Aquamantys System™

SERVICE MANUAL

TISSUELINK™
Simply Better Surgery

SERVICE MANUAL

Software Version 1.10

TISSUELINK
Simply Better Surgery
TM

Foreword

The Aquamantys™ Pump Generator is for use only by qualified medical personnel properly trained in the use of electrosurgical equipment, technology and techniques. This Service Manual is a guide for maintaining and servicing the Aquamantys Pump Generator. Additional clinical usage information is available in the Aquamantys Pump Generator Users Guide and in the Instructions for Use which accompany individual Aquamantys Disposable Bipolar Devices which are designed to be used as a part of the Aquamantys System.

Precaution: *Federal (USA) Law restricts this device to sale, distribution or use by or on the order of a physician*.

Equipment covered in this manual:

Aquamantys™ Pump Generator

Nominal Supply Voltage	Tissuelink Model #
100V 50/60Hz	40-401-1
115V 50/60Hz	40-402-1
230V 50/60Hz	40-403-1

CE 0123

TÜV C NRTL US

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Section 1 - Introduction

General Description

The Aquamantys™ Bipolar Pump Generator is an electrosurgical generator with a rotary peristaltic pump which is for use only with Aquamantys single-use disposable bipolar devices for concurrent delivery of radio-frequency energy with saline for hemostatic sealing of blood vessels in soft tissue and bone.

RF Power

The Aquamantys Pump Generator delivers bipolar RF power with power settings in 5 watt increments in the range of 20 to 100 watts, and 10 watt increments in the range of 100 to 200 watts. At higher tissue resistances the unit senses the high resistance and reduces the RF power output, independent of the front panel setting, to a level which prevents arcing or cutting.

Simultaneous RF Power and Saline Delivery

The Aquamantys Pump Generator simultaneously delivers RF power and saline to an Aquamantys disposable bipolar device when the device is properly connected to the unit and the activation button on the device is depressed. The Pump Generator is for use only with Aquamantys single-use disposable bipolar devices.

Saline Flow Rate Setting

The saline flow rate setting is determined based on the power setting and the selection of one of three possible flow rate settings: low, medium and high. The three possible saline flow rates for each power setting are preset automatically in order to provide the optimal saline flow for a given power setting.

Priming

The Aquamantys Pump Generator has a convenient one touch priming function which automatically primes the Aquamantys disposable bipolar device with saline prior to use after the device has been correctly connected to the unit. This function is activated by pressing the "START PRIME" button on the unit.

Precaution: *The "Start Prime" button activates and deactivates the timed priming cycle. Pressing the button a second time will immediately stop the priming cycle. Pressing the button a third time will reset the timer and restart the priming cycle from the beginning.*

Section 2 - Controls, Indicators, and Receptacles

This section contains information about the front and rear panels, including all controls, indicators, receptacles, and the fuse drawer.

Figure 2-1. Front Panel

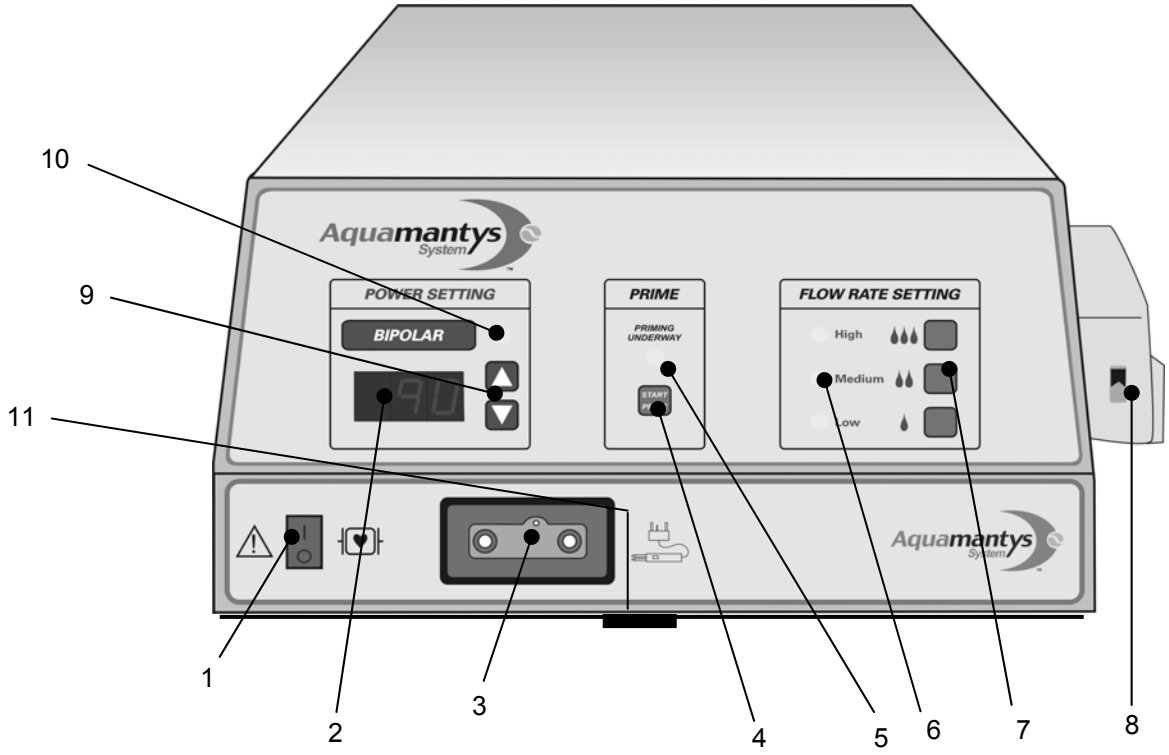
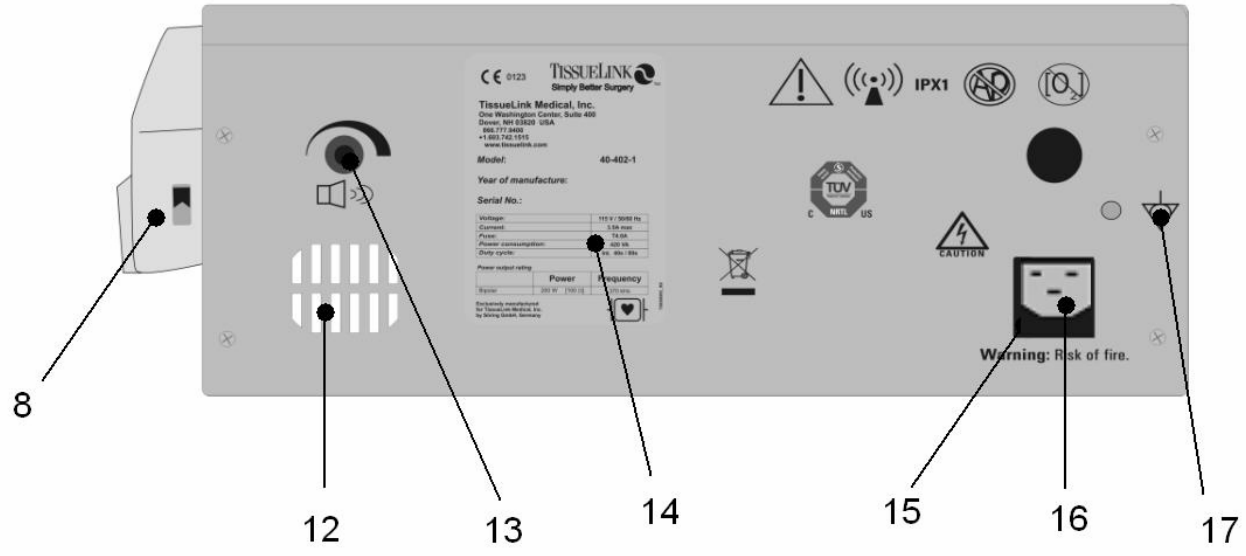


Figure 2-2. Rear Panel



1 Power On/Off Switch

The main power On/Off switch is located at the bottom left corner of the front panel on the Aquamantys Pump Generator.

The unit is switched on by pressing the top portion of the switch marked "|". The switch will be illuminated green when it is on.

The unit is switched off by pressing the bottom portion of the switch marked "**O**". It is recommended that the unit be switched off when it is not intended to be use for an extended period of time.

2 RF Power Indicator

This indicator displays the power setting numerically in watts. Additionally, this indicator is used to display errors, in which case the display will show "**Err**" and blink alternately with a special error code number(s).

3 Aquamantys™ Disposable Bipolar Device Receptacle

This plug receptacle is used to connect a 3-pin plug of an Aquamantys disposable bipolar device to the Aquamantys Pump Generator.

4 Start Prime Button

This button activates and deactivates the timed priming cycle. Pressing this button once automatically primes the Aquamantys disposable bipolar device with saline prior to use. The pump will operate for a preset time period to prime the Aquamantys device. After the time period is complete, the pump shuts off automatically.

Precautions: *Priming is required to avoid RF power activation without saline. The Aquamantys disposable bipolar device is primed when saline drips from each of the two tips of the device. Failure to prime the device may result in RF power activation without saline. Activation without saline may result in charring or damage to the electrodes of the device lead to a decrease in the hemostatic effectiveness of the device.*

The "Start Prime" button activates and deactivates the timed priming cycle. Pressing the button a second time will immediately stop the priming cycle. Pressing the button a third time will reset the timer and restart the priming cycle from the beginning.

5 Priming Underway Indicator

This indicator will be illuminated during the priming cycle and turn off when the priming cycle is complete.

6 Flow Rate Setting Indicators

These indicators corresponding to a saline flow rate setting of LOW, MEDIUM or HIGH. One of these three indicators will be illuminated when a saline flow rate setting is selected.

7 Flow Rate Setting Buttons

These buttons control the saline flow rate. Pressing one of these three buttons selects the flow rate setting of either LOW MEDIUM or HIGH for each respective power setting. The MEDIUM flow rate setting is automatically selected as the default setting if no setting is manually selected.

8 Saline Pump

This is a rotary peristaltic pump. A special pump segment is attached to the saline delivery tubing of each Aquamantys disposable bipolar device is designed to operate with the pump head of the pump. The pump segment is loaded into this pump head prior to operation of the device.

Precaution: *Only the pump segment portion of the saline delivery tubing of the Aquamantys disposable bipolar device should be loaded into the pump head. Use of any other portion of the saline delivery tubing of the device or any other tubing in this pump may damage the saline delivery tubing and/or the pump. Incorrect insertion of the pump segment may also result in RF power activation without saline. Activation without saline may result in charring or damage to the electrodes of the device lead to a decrease in the hemostatic effectiveness of the device.*

Always close the pump head prior to priming or device activation. Always allow the pump head rotor to come to a complete stop prior to opening the pump head. Do not attempt to load or adjust the positioning of the pump segment of the Aquamantys disposable bipolar devices in the pump head while the pump head rotor is turning. Fingers or loose clothing could be caught in the pump rollers.

9 RF Power Setting Buttons

These buttons control the RF power setting. Press the △ button to increase the RF power. Press the ▽ button to decrease the RF power.

10 RF Power Activation Indicator

This indicator will illuminate blue when RF power is activated.

11 Aquamantys™ Quick Reference Guide Pullout Tray

The Aquamantys Quick Reference Guide provides basic set-up and operating instructions and illustrations for the Aquamantys System.

12 Loudspeaker

13 Volume Control Knob

This knob controls the volume of the tone that will sound when the RF power is activated (RF power activation tone). To increase the volume of the RF power activation tone, turn the knob clockwise. To decrease the volume of the RF power activation tone, turn the knob counterclockwise. The tone cannot be silenced.

Warning: *Do not place adhesive tape or any other muffling device over the loudspeaker.*

14 Name Plate

This plate specifies the model number, serial number, nominal line voltages, frequency, current and fuse rating information of the Aquamantys Pump Generator.

15 Fuse Drawer

This fuse drawer contains two fuses. The Aquamantys Pump Generator Service Manual contains information for changing fuses.

16 Power Cord Receptacle

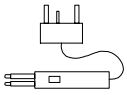
This plug receptacle is used to connect the main power cord to the Aquamantys Pump Generator. The power cord should only be connected to a source of power corresponding to that listed on the Name Plate.

17 Equipotential Grounding Lug Connector

This lug connector is used to connect the Aquamantys Pump Generator to earth ground.

Symbols

Several symbols appear on the Aquamantys Pump Generator front panel, rear panel, and pump head.

Symbol	Indicates	Symbol	Indicates
	**ATTENTION** – Consult accompanying documents		This equipment intentionally supplies non-ionizing RF energy for physiologic effect
	Defibrillation-Proof Type CF Applied Part		Volume control of RF power activation tone.
	**DANGER** Explosion risk if used with flammable anesthetics.		Do not operate in oxygen-enriched environments
	To reduce the risk of electric shock, do not remove the cover. Refer servicing to qualified personnel.	**High** 	High setting for saline flow rate
	Equipotential grounding lug	**Medium** 	Medium setting for saline flow rate
	Bipolar Device	**Low** 	Low setting for saline flow rate
	CE Mark		Caution: Moving Parts – Risk of Injury.
	TUV NRTL Mark	**IPX1**	This equipment has passed water-ingress testing
	Do not discard in trash. Electronic equipment should be disposed of in an appropriate manner.		Activates/deactivates device priming sequence

Section 3 - Technical Specifications

Performance Characteristics

General

Output Configuration	Isolated output
Cooling	Internal fan, natural convection on outside of chassis
Display	Three (3) digital seven-segment displays: 0.55 inches (1.4 cm) each

Dimensions and Weight

Width	12.2 inches (31.0 cm)
Depth	15.2 inches (38.5 cm)
Height	5.9 inches (15.0 cm)
Weight	31.5 lbs (14.3 kg)

Operating Parameters

Ambient temperature range	50° to 104° F (10° to 40° C)
Relative humidity	15% to 75%, noncondensing
Air pressure	524 to 795 mmHg (700 to 1060 hPa)

Transport and Storage

Ambient temperature range	-29° to 149° F (-34° to 65°C)

Duty Cycle

At maximum output settings (200 Watts) and rated load conditions (100 Ohms) the unit may be safely operated for activation times of 40 seconds on, 80 seconds off, for 1 hour. With reduced power settings, you can activate the unit for greater durations without generating excess internal temperatures.

Internal Memory

During power failures, this unit has short time storage of the adjusted values. If the power fails for less than 10 seconds, the unit will restore the last adjusted working parameters.

Audio Volume

The audio level is for the activation tone and alarm tone at a distance of one meter. Alarm codes meet the requirements of IEC601-2-2.

Activation Tone

Frequency (nominal) 940 Hz

Alarm Tone

Frequency (nominal) 349, 415, 524, 698 Hz

Leakage Currents

See IEC test record

Electromagnetic Compatibility

The Aquamantys Pump Generator is intended for use in the electromagnetic environment specified below. The customer or user of the unit should assure that it is used in such an environment.

Immunity Test	**IEC (60)601-1-2:2001 Test Level**
Conducted emission *DIN EN 55011, FCC Part 18, class B, consumer class*	150 kHz - 30 MHz:
Radiated emission *DIN EN 55011, FCC Part 18, class B, non consumer class*	30 MHz - 1 GHz
Electrostatic discharge *DIN EN 61000-4-2*	± 6 kV Contact discharge ± 8 kV Air discharge
Immunity to electromagnetic fields *DIN EN 61000-4-3*	10 V/m 80 - 2500 MHz
Immunity to conducted fast transients *DIN EN 61000-4-4*	Burst: ± 2 kV power mains ± 1 kV signallines
Immunity to conducted slow transients *DIN EN 61000-4-5*	Surge 1.2/50µs: ± 2 kV $_{unsym}$ /± 1 kV $_{sym}$ power mains
Immunity to conducted disturbances induced by RF-fields *DIN EN 61000-4-6*	10 V_{rms} 150 kHz - 80 MHz power mains / signallines
Voltage dips, short interruptions *DIN EN 61000-4-11*	Complies
Harmonic current emission *DIN EN 61000-3-2, class A*	Complies
Voltage fluctuation and flicker *DIN EN 61000-3-3*	Complies

LEDs

All LEDs inside the Aquamantys are CLASS 1 LED PRODUCT according to EN60825-1.

Input Power

The nominal mains voltage is factory selected. Refer to the rear panel markings for correct mains voltage.

Nominal V_{RMS}	Minimum V_{RMS}	Maximum V_{RMS}	Max Current A_{RMS}	Fuse Rating	Type of fuse
100	90	110	4.00	T5.0A	5x20mm, Glass fine fuse
115	104	127	3.50	T4.0A	5x20mm, Glass fine fuse
230	207	253	1.85	T2.0A	5x20mm, Glass fine fuse

Mains line frequency (nominal): 50/60 Hz

Maximum power consumption: 420 VA

Mains cable: **3-conductor hospital grade**

Standards and IEC Classifications

ATTENTION

Consult accompanying documents.

To reduce the risk of electric shock, do not remove the cover. Refer servicing to qualified service personnel.

DANGER

Explosion risk if used with flammable anesthetics.

Class I Equipment

Accessible conductive parts cannot become live in the event of a basic insulation failure because of the way in which they are connected to the protective earth conductor.

Type CF Equipment /Defibrillator Proof

This unit provides a high degree of protection against electric shock, particularly regarding allowable leakage currents. It is type CF isolated (floating) output.

Drip Proof

IPX1

This unit enclosure is constructed so that liquid spillage in normal use does not wet electrical insulation or other components which, when wet, are likely to affect adversely the safety of the unit.

Static Electricity Discharge Interference

This unit enclosure can withstand an 8 kV electrostatic air discharge.

Electromagnetic Compatibility

This unit complies with the appropriate IEC 601-1-2 and 601-2-2 specifications regarding electromagnetic compatibility.

Voltage Transients (Emergency Mains Transfer)

This unit operates in a safe manner when the transfer is made between line AC and an emergency unit voltage source.

Output Characteristics

Maximum Pump Generator Output

Mode	Maximum Open Circuit Voltage V_{pp} (V_p)	Maximum Short Circuit Current A_{rms}	Maximum Power Setting Watts	Crest Factor
Bipolar	650 (325)	3.2	200	1.5

RF Output

Output Power	20 to 200 watts
Adjustable Power Increments	5 watts, from 20 to 100 watts 10 watts, from 100 to 200 watts
Load Range	50 to 110 ohms
Rated Load	100 ohms

Output Waveform

Bipolar	370 kHz sinusoid, ± 10%, continuous

Saline Flow Rate

Priming Flow Rate	36 mL/min, ±15%
Priming Time	41 seconds, ± 2
Flow Rate	0.5 to 36 mL/min, depending on power setting and flow rate setting

All specifications are valid for software version 1.10 and above.

All specifications are nominal and subject to change without notice.

Figure 3-1. Output Voltage vs. Power Setting

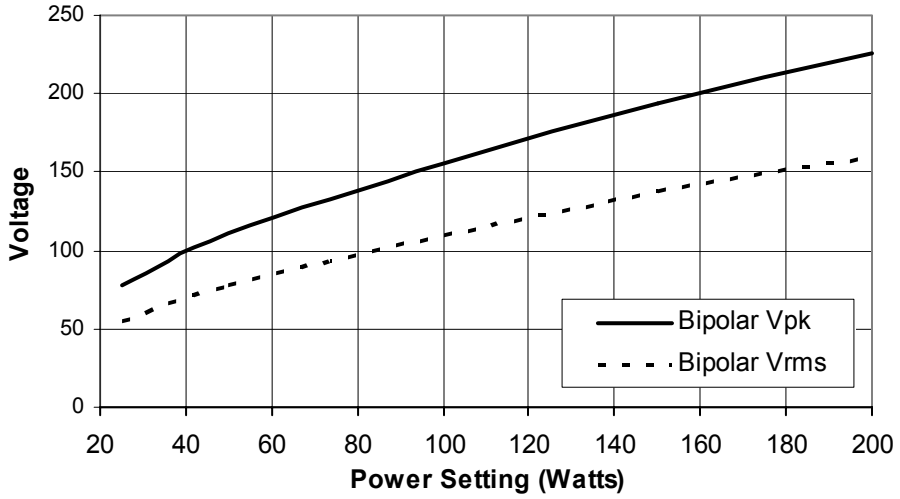


Figure 3-2. Output Power vs. Resistance

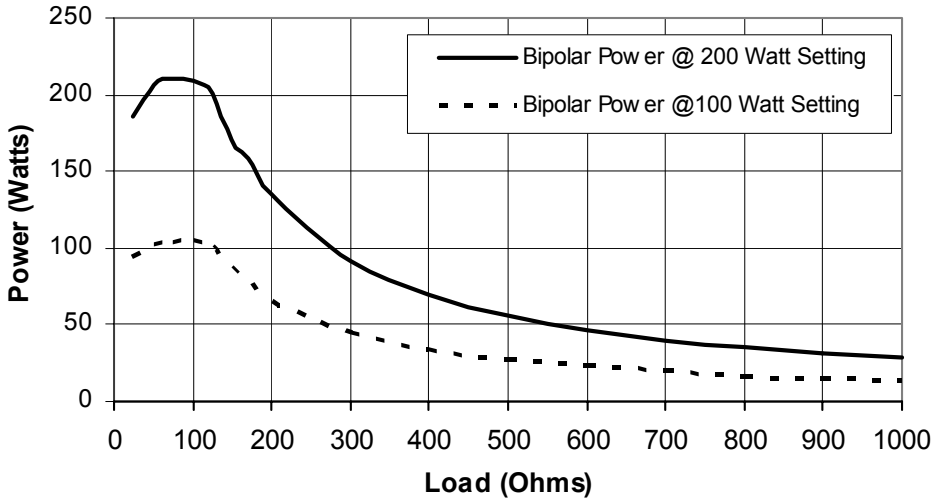


Figure 3-3. Saline Flow Rate vs. Power Setting

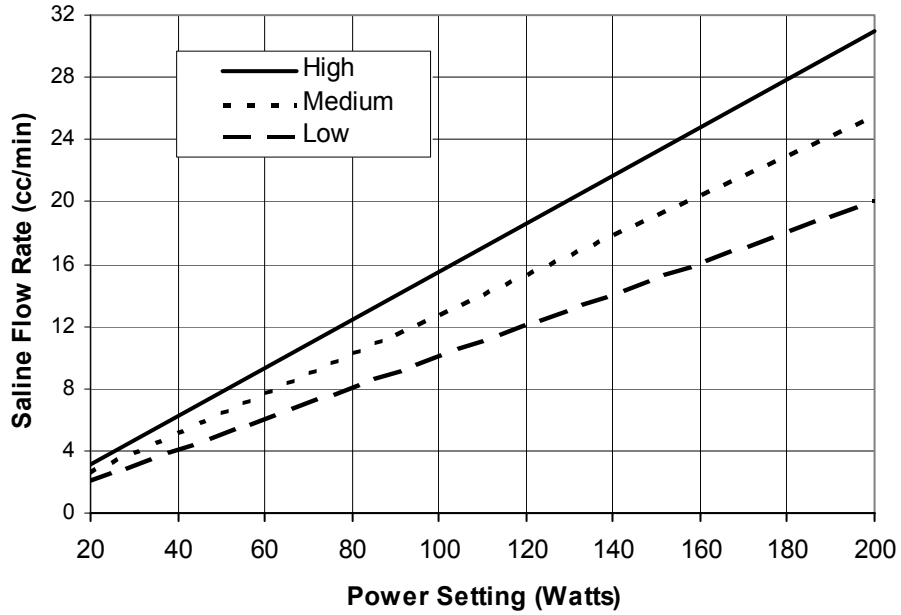
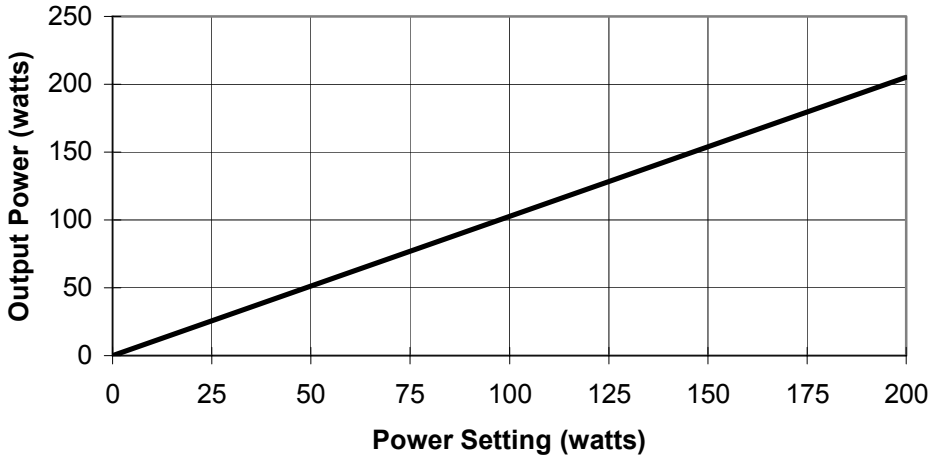


Figure 3-4. Power Setting Characteristics at rated load



Accessories

Aquamantys System Power Cords

Part #	Country(s)	Voltage	Length	Connectors
30-501-1	North American	115V	12 feet	IEC 60320-C13 to NEMA 5-15
30-501-2	European	230V	12 feet	IEC 60320-C13 to Europlug CEE 7/16
30-501-3	Japanese	100V	12 feet	IEC 60320-C13 to JIS 8303

Aquamantys System Fuses

Nominal V_{RMS}	Minimum V_{RMS}	Maximum V_{RMS}	Max Current A_{RMS}	Fuse Rating	Type of fuse
100	90	110	4.00	T5.0A	5x20mm, Glass fine fuse
115	104	127	3.50	T4.0A	5x20mm, Glass fine fuse
230	207	253	1.85	T2.0A	5x20mm, Glass fine fuse

For a listing of additional Aquamantys System accessories please refer to the TissueLink Medical Product Catalog.

Section 4 - Circuitry Description

Overview

The Aquamantys Pump Generator is comprised of the following components:

- Power supply unit with mains transformer, power supply PCB (Supply_TL1) with rectifiers, filter capacitors and an inrush current limitation circuit.
- RF generator PCB (RFGEN_TL1). This PCB comprises the entire internal voltage processing circuit, the RF generator, the motor controller for the peristaltic pump, 2 microcontrollers for sequence control and monitoring the entire process.
- Display PCB with controls and displays.
- Rotary peristaltic pump head with drive unit.
- Metal housing.

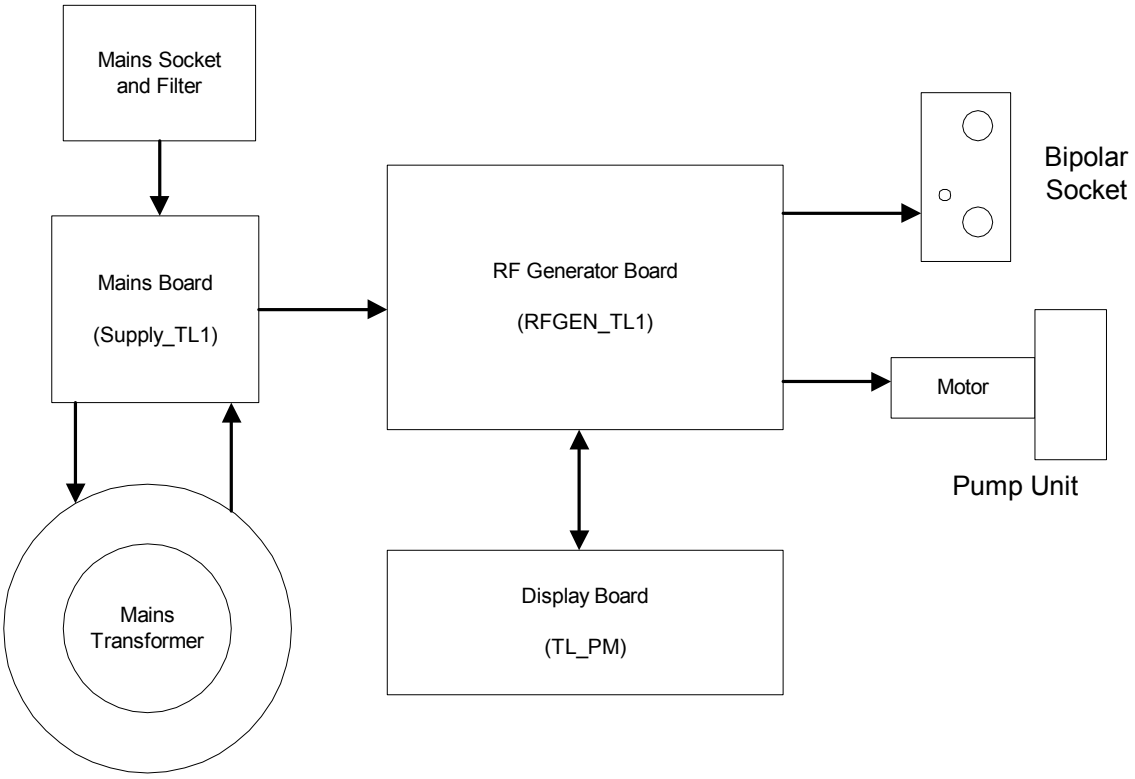


Figure 4-1. General Block Diagram

Description of unit components

Primary power supply

Mains voltage reaches the power supply PCB via a line filter socket and an illuminated power switch. The mains transformer connects to this PCB.

The mains voltage reaches the mains transformer's split primary winding via an inrush current limitation circuit and a voltage selector (115 V/230 V). The secondary voltages from the mains transformer are rectified and filtered with electrolytic capacitors.

Power is then supplied via a connector between power supply PCB and the RF generator PCB.

Fuses in the primary power supply:

- 2-pole protection in the line filter socket (2 A / 4 A slow-blow micro-fuses, depending on the mains voltage 230 V / 115 V)
- 2.5 A slow-blow microfuse at the 160 V output on the power supply PCB
- Self-resetting PTC fuses downstream of the filter capacitors for low-voltage supply

The mains transformer is used for potential separation between mains and the electronic components. It features the following primary windings:

- 115 V with 100 V tap for Japan and USA (blue, brown, green)
- 115 V; series connection with the 1st primary winding for 230 V (green, yellow)

Secondary windings:

- 115 V, 2.5 A for the RF generator
- 2 windings @ 20 V for small signal component and pump motor supply

The mains transformer connects to the power supply PCB via 2 connectors (primary/secondary side). Pin assignment:

- Primary (5-pole, from the front):
  - Blue: 0 V (first primary winding start)
  - Brown: 100 V (Japan)
  - Green: 115 V (USA)
  - Green: 115 V (second primary winding start)
  - Yellow: 230 V (second primary winding end, Europe)

- Secondary
  - Red, red: 115 V (power stage supply)
  - Orange, purple: 21 V (small signal component/pump motor supply)
  - Gray, white: 21 V (small signal component/pump motor supply)

The power supply PCB (Supply_TL1) and the mains transformer comprise the power supply unit, which is mounted on an aluminum plate. This power supply unit is fastened in the housing with 4 screws. The mains voltage reaches the Supply_TL1 circuit input (mains socket, J1) via the line filter socket and the power switch. An inrush current limiting circuit (consisting of a thermal fuse and power resistor) is switched in or out by a relay controlled by the "voltage monitor". The current limiting circuit is engaged if the mains voltage falls below 70% of the setpoint for longer than approximately 50 ms and is switched out when the mains voltage exceeds at least 70% of the normal mains voltage for approximately 0.5 seconds. The same percentages and timing apply to the POWER_GOOD signal (see below).

The voltage selector connects the mains voltage either to the first 115 V winding (115 V operation) or to both primary windings connected in series (230 V operation). Application of the 100 V winding (Japan operation) requires a special variant of the power supply PCB. The "Primary Socket" connector connects the mains transformer primary winding.

The secondary voltages are rectified (bridge rectifier) and filtered with electrolytic capacitors.

The voltage monitor drives the current limitation resistor bypass relay and generates the "POWER_GOOD" signal. In case of a relay failure the resistor will heat up considerably. A thermal fuse will then interrupt the circuit and protect the resistor from overheating.

Connector J4 supplies the following unregulated voltages and signals. From fuse FU3:

- Approximately 160 VDC (RF generator power stage)
- Approximately +/- 28 VDC (small signal components, pump motor)
- "Power Good" signal (is issued when the mains voltage has reached at least approximately 70% of the rated value).

Vital circuits are also protected. The respective fuses are to be found on the power supply PCB

- Secondary 115 V winding, FU2: T3.15A (on the secondary connector)
- RF generator power stage, FU3: M2.5 A (RF generator connector)
- 21 V secondary voltages, FU4, FU5 (self-resetting)
- Low-signal voltages (28 V), FU6, FU7 (self-resetting)

LEDs:

Three LEDs indicate the presence of output voltages and the power status (POWER-GOOD). The following must be lit:

- LED1: unregulated operating voltage for RF generator power stage.
- LED2: positive unregulated operating voltage for RF generator low-signal stage.
- LED3: negative unregulated operating voltage for RF generator low-signal stage.

- LED4: POWER-GOOD.

Note: The LEDs protrude over the PCB edge and can be seen after removal of the floor panel.

The output socket pin assignment is as follows (starting from fuse FU3):

- PIN1 – 2: + / - 160 V, filtered, unregulated
- PIN3: POWER-GOOD signal
- PIN4, 5, 6: -28 V, GND, +28 V filtered, unregulated

This connector is used to supply the RF generator PCB (RFGEN_TL1).

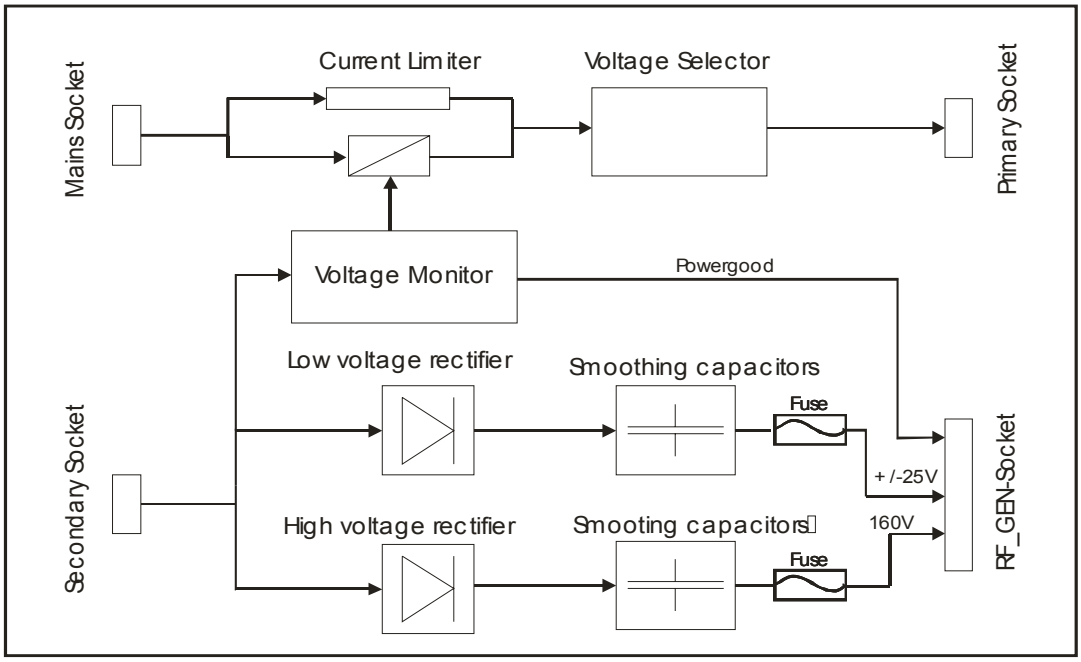


Figure 4-2. Power Supply Block Diagram

RF Generator Circuit Board (RFGEN_TL1).

The RF generator PCB comprises all components of an RF device and also the voltage regulator for the pump motor.

Power is fed in via the “from power supply” input on the power supply PCB (Supply_TL1). Fixed voltage regulators reduce the supplied low voltages (+/- 25V) to +5 V (for the microcontrollers and the display) and +/-15 V for the small signal components. “U1_Voltage Regulator” provides the variable voltage (0 to 100 V) for the RF generator.

The RF output voltage is directly proportional to the U1 voltage. The output power is measured and the U1 operating voltage automatically reduced if the set power is exceeded. The same happens when the maximum current is reached. A microcontroller (MPU0) provides the values for maximum RF power, maximum RF current and RF voltage.

The “power monitor” measures the power generated by the RF generator and forwards the values to the 2nd microcontroller (MPU1). The unit is turned off and an error alarm is issued if due to a fault a power higher than the one set is measured.

The RF signal then reaches the Aquamantys disposable bipolar device via an output transformer, the patient protection capacitor and a socket. The bipolar device features a pushbutton for unit activation whose actuation is indicated to MPU1 by the “switch monitor”.

The RF generator supplies a maximum RF voltage of approximately 250 Vpp and a maximum current of 3.2 A. The signal is sinusoidal with a frequency of approximately 370 kHz.

The saline solution is metered by selecting a motor voltage proportional to the RF power.

Each MPU circuit features one watchdog circuit in order to improve the software security. RF signal activation is possible only if the “safety trigger circuit” is periodically triggered.

RF generator PCB interfaces:
- Supply PCB for RF generator PCB power supply
- RF output socket (for connecting the unit’s applicator socket)
- Socket for the pump motor
- Socket for the display (power supply (5 V) and I^2C bus

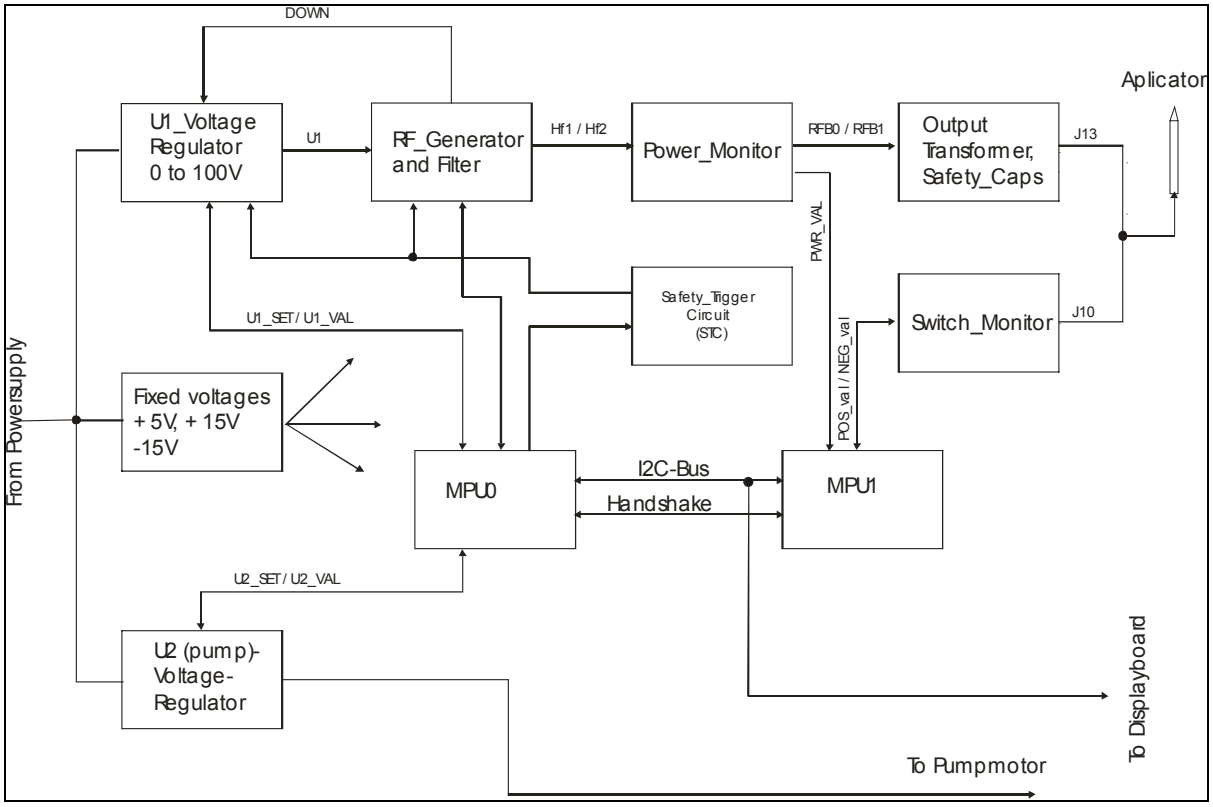


Figure 4-3. RF Generator Block Diagram

The display circuit board (TL_PM)

The display (TL_PM PCB) is connected to the RF generator PCB. Power supply (+5 V) and communication (I^2C bus) occur directly from the RF generator PCB.

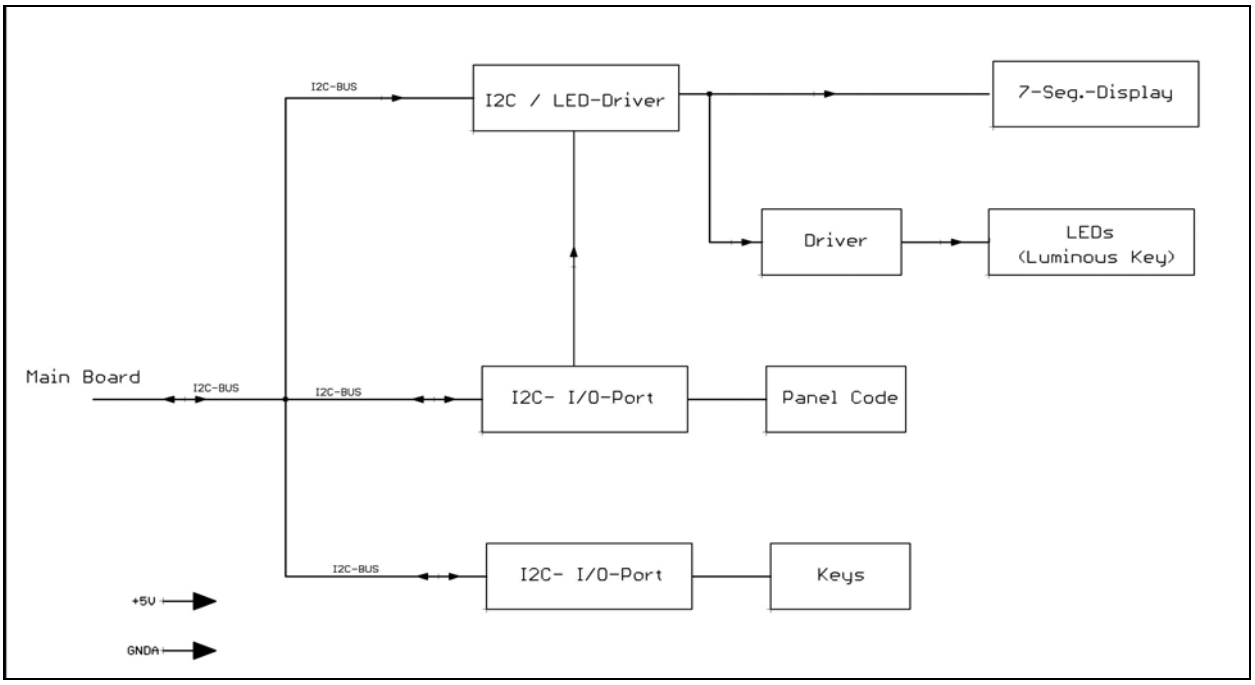


Figure 4-4. Display Board Block Diagram

Section 5 - Testing and Servicing Safety

Warnings: ***Shock Hazards:***

All servicing should be referred to qualified service personnel. It is recommended that you contact the TissueLink Medical Customer Service Department to have the Aquamantys Pump Generator serviced.

Potentially lethal voltages are present within the unit when energized. Use extreme caution if the bottom panel is removed for maintenance or attempted repair. Servicing the unit when it is energized is NOT recommended.

Always turn off and unplug the Aquamantys Pump Generator and wait for several minutes (capacitor bleed down delay) before disassembling or servicing.

The Aquamantys Pump Generator power cord must be connected to a properly grounded receptacle during normal use or testing.

Burn Hazards:

High frequency, high voltage signals are present on the output circuit when activated. These signals can cause severe burns. Extreme caution must be used when testing or troubleshooting the output of the pump generator.

Load resistors used to test the output of the pump generator will become extremely hot. Use extreme caution to avoid any contact. All load resistors must be properly mounted and isolated from any flammable materials.

The Aquamantys Pump Generator power cord must be connected to a properly grounded receptacle during normal use or testing. Do not use extention cords or adapter plugs.

Precautions: *All warnings and precautions accompanying the Aquamantys Pump Generator should be read and understood prior to attempting any testing or servicing of the unit.*

Use static control practices when handling internal electrostatic sensitive circuitry. A ground strap should be utilized when servicing the Aquamantys Pump Generator unless the unit is energized. Servicing the unit when it is energized is not recommended.

When performing accuracy measurements, keep all leads as short as possible and keep leads away from metallic surfaces.

Observe stated duty cycle when testing or servicing unit. The Aquamantys Pump Generator is not intended for continuous activation for extended periods of time.

Section 6 - Maintenance and Repair

Responsibility of the Manufacturer

TissueLink Medical is responsible for the safety, reliability, and performance of the Aquamantys Pump Generator only under the following circumstances:

- Installation and setup procedures in this manual are followed.
- Assembly operation, readjustments, modifications, or repairs are carried out by persons authorized by TissueLink Medical, Inc.
- The electrical installation of the relevant room complies with local codes and regulatory requirements.
- The equipment is used in accordance with the Aquamantys System instructions for use.

Routine Maintenance

Recommended Periodic Service Interval

The Aquamantys Pump Generator should be serviced according to your hospital's equipment servicing guidelines. TissueLink Medical recommends that the unit's calibration be verified and a safety check be performed by a qualified service technician on an annual basis.

Recommended Periodic Service Procedure

The calibration check and safety inspection should include:

- Protective earth conductor test
- Earth leakage current measurement
- Housing leakage current measurement
- Patient leakage current measurement
- RF leakage current measurement at maximum power with no-load.
- Output power accuracy verification
- Peristaltic pump test (function, flow rate accuracy)
- Test of visual indicators
- Test of alarm tone and volume control function
- Power cord inspection (for damage)
- Fuse check

Recommended test equipment:

- Safety tester for medical units as per IEC60601
- RF power meter for RF surgery systems
- Stopwatch

Leakage currents and protective earth conductor test

The following connections should be established according to the safety tester's instructions:

- Male end of Aquamantys Pump Generator's power cord into the safety tester mains socket.
- Aquamantys' equipotential bonding terminal (see section 2, item #17 for location) to safety tester respective terminal.
- Aquamantys' bipolar output sockets to safety tester applied part terminals.

Perform leakage and PE conductor tests per the safety tester instructions. The following limits must be complied with in accordance with IEC60601 (Class I, Type CF device):

Table 6-1. Leakage Current and PE Conductor Limits

Measured Characteristic	Maximum Value
PE conductor impedance	0.2 Ω
Earth leakage current, normal condition	500 μA
Earth leakage current, single fault condition	1000 μA
Housing leakage current, normal condition	100 μA
Housing leakage current, single fault condition	500 μA
Patient AC leakage current, normal condition	10 μA
Patient DC leakage current, normal condition	10 μA
Patient AC leakage current, single fault condition	50 μA
Patient DC leakage current, single fault condition	10 μA

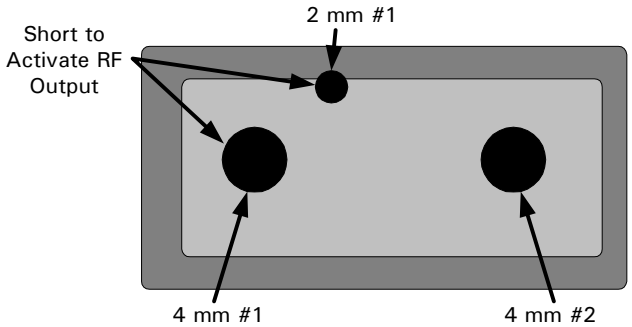
RF leakage current

The RF leakage current may be measured with the safety tester used in the previous leakage tests if that function is available. If not, it may be directly measured with a high frequency current sensing coil (i.e.: Pearson Electronics model #4100), a precision voltmeter and a noninductive 200 Ω load resistor.

The RF leakage is the current which flows from one side of the Aquamantys bipolar output socket through 200 Ω to the Aquamantys equipotential bonding terminal. During this measurement, the RF output must be active at the maximum power setting (200 watts). Both outputs of the bipolar output socket (4mm connector #1 and 4mm connector #2) should each be tested one at a time. The RF leakage current should not exceed 100 mA.

In the absence of an Aquamantys bipolar disposable device, the Aquamantys Pump Generator bipolar RF output may be manually activated by ***carefully*** shorting the 2mm banana style connector #1 to 4mm banana style connector #1 as shown in figure 6-1 below.

Figure 6-1 Aquamantys Bipolar Output Socket; RF Output Activation



Warnings: *High frequency, high voltage signals are present on the output circuit when activated.* ***These signals can cause severe burns. Extreme caution must be used*** *when testing or troubleshooting the output of the pump generator.*

When 2mm connector #1 is shorted to 4mm connector #1, the Aquamantys bipolar RF output will be active from 4mm connector #1 to 4mm connector #2.

RF Output Power Accuracy Verification

Warnings: *Load resistors used to test the output of the Aquamantys Pump Generator will become extremely hot. Use extreme caution to avoid any contact. All load resistors must be properly mounted and isolated from any flammable materials.*

Precautions: *The RF power meter must have a current rating of at least 2.5 A_{rms}. Do not test the Aquamantys Pump Generator with a load of less than 50 ohms on the output – RF currents in excess of 2.5 amps rms will occur.*

It is preferable that these measurements be performed using an electrosurgical tester which is intended for this purpose, however it is possible to perform this testing manually if required. The manual method is achieved with a high frequency current sensing coil (i.e.: Pearson Electronics model #4100), a precision voltmeter and 200W noninductive load resistors of appropriate resistive values. The delivered power will be calculated as I^2R. Also, manual RF output activation as described above will be required.

The RF output should be tested at both 100 watt and 200 watt settings with the output loaded at 50 ohms, 100 ohms and 150 ohms. At 50 ohm and 100 ohm loads, the measured RF output power should be equal to the set power ±20%. At the 150 ohm load, the measured RF power should be less than that measured at 100 ohms. The object is to compare the measured output power for any given load to the output power vs. resistance curve in the Technical Specifications section of this manual, applying a tolerance of ±20%.

Adjusting the RF Power Setting

Press the △ button to increase the RF power and press the ▽ button to decrease the RF power (Figure 6-2).

The RF power setting changes in increments of 5 watts in the range of 20 to 100 watts, and in increments of 10 watts in the range of 100 to 200 watts. If either button is held down the setting will change slowly, then more rapidly. Release the button when the desired RF power setting is displayed. An alarm tone will sound when the power reaches 200 watts and when it is lowered to 20 watts. The RF power setting cannot be adjusted while the unit is being activated.

Figure 6-2. Adjusting the RF Power Setting

Peristaltic pump test (function, flow rate accuracy)

Warnings: *Always close the pump head prior to activating pump motor. Always allow the pump head rotor to come to a complete stop prior to opening the pump head. Prevent fingers or loose clothing from being caught in pump head rotors.*

Verifying Proper Alignment of Pump Segment Guides

- To determine if pump segment guides are properly adjusted, first orient the Aquamantys Pump Generator so that the right side (pump side) is facing you.
- Check the pump segment guide adjustment tabs on both left and right sides of the pump head. For proper guide alignment, the adjustment tab should be positioned so that it is aligned between the 2nd and 5th locator teeth as shown in Figure 6-2. If necessary, adjust the tabs accordingly by first pressing inward toward the pump and then sliding either up or down as required.

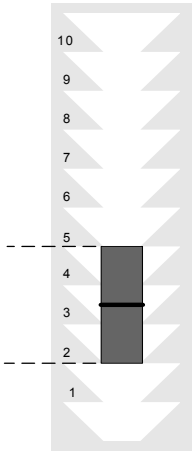


Figure 6-2. Guide Alignment

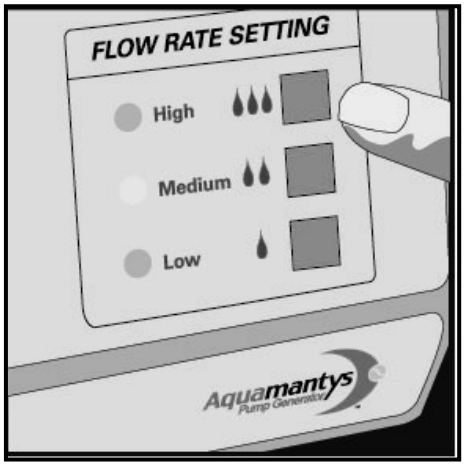
Adjusting Flow Rate Setting

The saline flow rate setting is adjusted by pressing the button next to the desired flow rate (Figure 6-3). Flow rate options include:

- High saline flow rate **High**
- Medium flow rate **Medium**
- Low flow rate **Low**

The Flow Rate Setting Indicator next to the selected flow rate will be illuminated amber to indicate the current flow rate setting. If a flow rate setting is not manually selected, the medium setting is selected as the default setting. The saline flow rate setting cannot be adjusted while the unit is being activated.

Figure 6-3. Adjusting the Flow Rate Setting



Verifying Proper Pump Head Rotation Rate

- If it is open, close the pump head by moving and locking the pump lever down toward the rear of the pump generator.
- Remove the black rubber plug on the pump face which covers the pump shaft.
- Mark a visual reference point near the outer circumference of the slotted end of the pump shaft using a felt tip marker or other means.
- Set the Aquamantys Pump Generator power output to 200 watts and the flow rate to low.
- Following the directions in the sections above, manually activate the Aquamantys RF output.
- Watching your reference marker on the slotted end of the pump shaft, observe that the pump shaft rotates essentially evenly without binding or stalling.
- Continuing to monitor your reference marker and, using a stopwatch as a timer, count the number of complete revolutions of the pump shaft in a period of 10 seconds. Repeat for medium and high flow settings.

Specifications:

Table 6-2. Flow Rate vs Pump Shaft Revolutions Limits

Flow Rate Setting	Min Revs / 10 sec	Max Revs / 10 sec
Low	11	15
Medium	15	20
High	18	24

The flow rate regresses to zero mL/min in a linear fashion, so there is no need to verify the flow rate at lower power settings.

Verifying Flow Rate Accuracy and Duration of Priming Function

The flow rate accuracy and duration of the priming function should also be verified as follows:

- Monitor the reference mark on the pump shaft as above and, using a stopwatch as a timer, press the prime switch (Figure 6-4) to initiate the priming process. Count the number of complete revolutions of the pump shaft in a period of 10 seconds. There should be between 21 and 28 revolutions in 10 seconds.

- If the pump is still running from the measurement above, wait for it to stop. Using a stopwatch, time the duration of the priming process. Initiate timing when the prime switch is pressed (Figure 6-4) and continue timing until the pump motor turns off. Total time should be between 39 and 43seconds.

Figure 6-4. Initiating the Priming Sequence

The "Start Prime" button activates and deactivates the timed priming cycle. Pressing the button a second time will immediately stop the priming cycle. Pressing the button a third time will reset the timer and restart the priming cycle from the beginning.

Test of visual indicators

During the power-up self-test of the Aquamantys Pump Generator, verify that all visual indicators illuminate.

Test of alarm tone and volume control function

Using manual procedure described in the RF Leakage Current section above, activate the bipolar output of the pump generator. Verify that there is an audible activation tone. Also verify that the volume of that tone can be adjusted (but not turned down to an inaudible range) with the volume control on the rear panel of the pump generator.

Power cord inspection

Inspect the power cord for any signs of exposed wires, cracks, frayed edges, or connector damage. Replace the power cord with an appropriate hospital grade replacement if any of these conditions or other evidence of damage exists.

Replacement power cords may be ordered from TissueLink Medical Customer Service by calling 866.777.9400 (+1.603.742.1515 outside U.S.).

Fuse check

Warnings: ***Shock Hazard.*** *Turn off and unplug pump generator prior to accessing the fuse holder.*

Check the rating of the fuses in the line filter on the rear of the Aquamantys Pump Generator for correct ratings. To do so, unplug the power cord from the generator. Using a flat bladed screwdriver, eject the fuse holder out of the line filter, remove the microfuses and check for correct rating:

Table 6-3. Fuse Ratings

Aquamantys type	Operating voltage	Fuse rating
40-401-1	100 V	T2.0 A
40-402-1	115 V	T4.0 A
40-403-1	230 V	T5.0 A

If necessary, replace the fuses with UL-certified (EN60127) fuses of the correct rating.

Returning the Aquamantys™ Pump Generator for Service

Before returning the unit to TissueLink Medical, call TissueLink Medical Customer Service for assistance.

If you are instructed to send the unit to TissueLink Medical, first obtain a Return Goods Authorization Number and then ship the unit to TissueLink Medical for service.

The unit should be cleaned prior to shipping and shipped in an appropriate packaging which protects the unit from damage (see below).

Step 1 – Obtain a Return Goods Authorization Number

Call the TissueLink Medical's Customer Service at 866.777.9400 (+1.603.742.1515 outside the U.S.) to obtain a Return Goods Authorization Number. Have the following information ready when you call:

- Hospital / clinic name / customer number
- Telephone number
- Department, street address, city, state or province (if applicable), zip/postal code and country if outside the U.S.
- Model number
- Serial number
- Description of the problem
- Type of repair to be done (if known)

Step 2 – Clean the Unit

Warnings: ***Electric Shock Hazard*** *Always turn off and unplug the unit before cleaning.*

Precautions: *Do not clean the unit with abrasive cleaning or disinfectant compounds, solvents, or other materials that could scratch the panels or damage the unit.*

1. Turn off the unit, and unplug the power cord from the wall outlet.
2. Thoroughly wipe all surfaces of the unit and power cord with a mild cleaning solution or disinfectant and a damp cloth. Follow the procedures approved by your institution or use a validated infection control procedure. Do not allow fluids to enter the chassis. The unit cannot be sterilized.

Step 3 – Ship the Unit

1. Attach a tag to the unit that includes the Return Authorization Number and the information (hospital, phone number, etc.) listed in *Step 1 – Obtain a Return Goods Authorization Number*.

2. Be sure the unit is completely dry before you pack it for shipment. Package it in its original shipping container, if available. If the original shipping container is not available, comparable packaging should be used to protect the Pump Generator from damage. Contact TissueLink Medical for a shipping carton if you do not have comparable packaging.

Ship the unit to TissueLink Medical, Inc., One Washington Center, Suite 400, Dover, NH, 03820 USA.

Section 7 - Troubleshooting

This section contains information about:

- General Troubleshooting Guidelines
- Troubleshooting Malfunctions
- Responding to Alarms

General Troubleshooting Guidelines

If the Aquamantys Pump Generator malfunctions, first check for obvious conditions that may have caused the problem:

- Check the unit for visible signs of physical damage.
- Make sure the fuse drawer is tightly closed.
- Verify that all cords are connected and attached properly.

Troubleshooting Malfunctions

If a solution is not readily apparent, use the table below to help identify and correct specific malfunctions. After you troubleshoot the malfunction, verify that the unit completes the self-test as described in Section 4.

Table 7-1. Troubleshooting

Situation	Possible Cause	Solution
No power	No power cord	Use power cord shipped with Aquamantys Pump Generator or contact TissueLink Medical Customer Service to obtain new power cord.
	Wrong power cord utilized	Use power cord shipped with Aquamantys Pump Generator or contact TissueLink Medical Customer Service to obtain new power cord.
	Faulty wall outlet	Insert power cord into a functioning wall outlet.
	Fuse drawer is open or fuses are blown.	Close the fuse drawer. Replace the blown fuse(s). Refer to the Service Manual.
	Wrong fuse	Use fuse listed in Aquamantys Pump Generator User Guide and/or Service Manual. Correct fuse is also listed on back panel of the unit.
	Unit not turned on	Switch unit on using the power switch located on the front panel of the unit
	Insufficient insertion of device plug into receptacle	Insure Aquamantys disposable bipolar device is fully inserted into device plug receptacle
	Insufficient insertion of power cord into unit or wall jack	Insure power cord is fully inserted into back of unit and wall jack.
	Damaged Aquamantys Pump Generator power cord	Contact TissueLink Medical Customer Service to obtain a new power cord.
	Damaged Aquamantys disposable bipolar device power cord	Discard device and obtain new device
	Internal component malfunction.	Contact Biomedical Engineering Department or a TissueLink representative for assistance. Use a backup Pump Generator or traditional hemostatic techniques to complete the surgical procedure if repairs cannot be made prior to the scheduled surgical procedure.
No saline when device activated	Pump segment not inserted correctly into pump head	Remove pump segment from pump head and reinsert correctly as indicated in User Guide.
	Saline bag positioned on side or upside down at a height below pump head	Insure saline bag is positioned right side up if used at a height below the pump head
	Pump head not closed	Close the pump head prior to use
	No saline source	Insure spike at end of device tubing set is correctly inserted into a 250 ml or larger I.V. bag of 0.9% sodium chloride solution
	Priming cycle not completed	Press “START PRIME” button once and insure priming cycle completes and saline drips from each of the two tips of the device.
	Priming button on unit pressed before the saline bag was spiked.	Press “START PRIME” button once and insure priming cycle completes and saline drips from each of the two tips of the device.

Situation	Possible Cause	Solution
No saline when device activated (continued)	Pump segment inserted in reverse orientation	Insure black connector on the Aquamantys disposable bipolar device pump segment is oriented to the left side of the pump head and the white connector to the right side of the pump head when pump head is inserted.
	Inadequate supply of saline	Replace used bag of 0.9% sodium chloride solution with a new bag.
	Saline line kinked/compressed/occluded	Insure Aquamantys disposable bipolar device pump segment is properly aligned in the pump head. Insure saline line is not kinked, compressed, or occluded by OR equipment, instruments, or personnel.
	Non-Aquamantys bipolar device connected to Pump Generator.	Insure device connected to Pump Generator is an Aquamantys device (Aquamantys logo on the side of the device). If incorrect device is being utilized, discard and utilize correct Aquamantys disposable bipolar device.
	All saline exits at tip of Aquamantys disposable bipolar device clogged by tissue or coagulated blood	Discard device and obtain new device
	Aquamantys disposable bipolar device pump is jammed by pump segment connector which has inadvertently entered into pump head.	Guide slots on pump head housing may be out of adjustment. Contact TissueLink Medical. Use a backup unit or traditional hemostatic techniques to complete the surgical procedure.
	Source of normal saline is a non-vented glass bottle.	Open vent cap on Aquamantys disposable bipolar device drip chamber.
Incorrect saline flow when device activated	Pump segment not inserted correctly into pump head	Remove pump segment from pump head and reinsert correctly as indicated in User Guide.
	Saline bag height below pump head	Insure saline bag is positioned at a height above the pump head
	Saline delivery tubing inserted into pump head instead of pump segment.	Remove pump segment from pump head and reinsert correctly as indicated in User Guide. Insure black connector on the Aquamantys disposable bipolar device pump segment is oriented to the left side of the pump head and the white connector to the right side of the pump head when pump head is inserted.
	Air bubbles in line due to incorrect priming technique	Press "START PRIME" button once to reprime the device in order to remove air bubbles.
	Saline line kinked or compressed	Insure Aquamantys disposable bipolar device pump segment is properly aligned in the pump head. Insure saline line is not kinked, compressed, or occluded by OR equipment, instruments, or personnel.
	Incorrect (non-Aquamantys) disposable device utilized	Insure device connected to Pump Generator is an Aquamantys device (Aquamantys logo on the side of the device). If incorrect device is being utilized, discard and utilize correct Aquamantys disposable bipolar device.
	One or more of the saline exits at tip of Aquamantys disposable bipolar device clogged by tissue or coagulated blood	Clean device tips with gauze. Ensure precautions are taken to avoid inadvertent device activation when cleaning device tips. If this does not correct the problem, discard device and obtain new device.
	Aquamantys disposable bipolar device pump segment is not inserted into pump head.	Insert pump segment into pump head as shown in User Guide.

Situation	Possible Cause	Solution
Generator doesn't work	Pump Generator damaged	Contact Biomedical Engineering Department or a TissueLink representative for assistance. Use a backup Pump Generator or traditional hemostatic techniques to complete the surgical procedure if repairs cannot be made prior to the scheduled surgical procedure.
	Pump Generator did not receive a scheduled safety check	Contact Biomedical Engineering Department or a TissueLink representative for assistance. Use a backup Pump Generator or traditional hemostatic techniques to complete the surgical procedure if repairs cannot be made prior to the scheduled surgical procedure. See Aquamantys Service Manual for maintenance schedule.
	Pump Generator plugged into an inappropriate wall outlet (e.g. not protected against ground fault, etc.)	Plug Pump Generator into an appropriate wall outlet prior to use.
Unit is on, but did not complete self-test.	Software or internal component malfunction.	Turn off, and then turn on the unit. If the error code reappears: • Record the error code number and refer to *Responding to System Alarms* in this section. • Use a backup Pump Generator or traditional hemostatic techniques to complete the surgical procedure.
Unit is on and disposable device is activated, but unit does not deliver output.	Power setting is too low	Increase the power. Refer to Section 5, *Changing the Power Setting.* Use the lowest possible power setting needed to obtain the desired effect.
	Malfunctioning Aquamantys disposable bipolar device or improper device connection.	Turn off the unit. Check the device connection. If device continues to malfunction, replace device and contact TissueLink Medical to report device malfunction.
	A malfunction condition exists.	Check the power display for an error code. Note the code number and refer to *Responding to Alarms* in this section.
	Internal component malfunction.	Use a backup Pump Generator or traditional hemostatic techniques to complete the surgical procedure. Contact your Biomedical Engineering Department or a TissueLink representative for assistance.
Interference with other device only when the unit is activated.	Metal-to-metal sparking.	Check all connections to the unit and device.
	Electrically inconsistent ground wires in the operating room.	Verify that all ground wires are as short as possible and go to the same grounded metal.
Continuous monitor interference.	Faulty chassis-to-ground connections.	Check and correct the chassis ground connections for the monitor and for the unit.
	Monitor responding to radiated frequencies	Check other electrical equipment in the room for defective grounds. If not resolved, contact Biomedical Engineering Department to check with the monitor manufacturer.

Situation	Possible Cause	Solution
Abnormal neuromuscular stimulation *(Stop surgery immediately)*	Metal-to-metal sparking	Check all connections to the unit and devices.
Ineffective hemostasis	Power setting too low	Increase the power. Refer to Section 5, *Changing the Power Setting.* Use the lowest possible power setting needed to obtain the desired effect.
	Tissue under-treated. Tissue not treated long enough to result in a reduction in intraoperative or postoperative blood loss	See Aquamantys disposable bipolar device instructions for use and/or device treatment guides for treatment recommendations.
	Wrong fluid used for device irrigation	Only utilize 0.9% sodium chloride solution with the Aquamantys System
	Tip(s) of Aquamantys disposable bipolar device clogged by tissue or coagulated blood	Clean device tips with gauze. Ensure precautions are taken to avoid inadvertent device activation when cleaning device tips. If this does not correct the problem, discard device and obtain new device.
	Excessive blood, fluid or saline in surgical field where device is being utilized	Utilized appropriate suction to remove blood, fluid and/or saline. See Aquamantys disposable bipolar device instructions for use and/or device treatment guides for treatment recommendations.
Unintended tissue effect	Power setting too high	Decrease the power. Refer to Section 5, *Changing the Power Setting.*
	Tissue over-treated	See Aquamantys disposable bipolar device instructions for use and/or device treatment guides for treatment recommendations.
	Non-Aquamantys bipolar device utilized	Insure device connected to Pump Generator is an Aquamantys device (Aquamantys logo on the side of the device). If incorrect device is being utilized, discard and utilize correct Aquamantys disposable bipolar device.
Excessive saline	Saline flow rate setting too high	Decrease saline flow rate. Refer to Section 5, *Changing the Flow Rate Setting.*
	Excess saline resulting from priming cycle	Place the device into a holster or over a container to collect the saline that will exit the tips of the device as a result of the priming process.
	2nd (or more) activation of priming cycle	Place the device into a holster or over a container to collect the saline that will exit the tips of the device as a result of the priming process.
	Off tissue device activation	Only activate the Aquamantys disposable bipolar device on/over tissue intended to be treated. Activation over another location may result in hot saline run-off onto unintended tissue, patient, patient drapes, hospital staff and OR surfaces.
	Pump head disengaged following procedure prior to placing bipolar device in waster receptacle	The Aquamantys disposable bipolar device and the saline bag will contain unused saline following use of the device. Place hand piece into waste receptacle prior to opening pump head and removing device pump segment.

Responding to Alarms

When the Aquamantys Pump Generator senses a malfunction, a sequence of alarm tones will sound and the RF power is disabled. Additionally, the RF Power Indicator will show "**Err**" and blink alternately with a special error code number(s).

1. Turn the Aquamantys Pump Generator off position by pressing the bottom portion of the power switch marked "**O**".
2. After 10 seconds, switched the unit on by pressing the top portion of the power switch marked "|"and verify that the self-test is successfully completed. During the self-test, all front panel LEDs will illuminate momentarily and an audible tone test will sound.

   If the automatic self-test is successfully completed (after about 6 seconds), the RF Power Activation Indicator will illuminate and the RF Power Indicator will display 20 watts.

   If the automatic self-test is not successfully completed, an alarm will sound, the RF power output is disabled, and an error code is displayed in the RF Power Indicator. Do not attempt to use the Pump Generator and refer to the Aquamantys Service Manual.

   If the display shows an alternating HP- and Err following the self-test, the self-test was executed while an Aquamantys disposable bipolar device was being activated. Simultaneous activation of the device during the self-test prevents the audio and visual indicators of the self-test from occurring. If this happens, release the button on the device.

   If all LEDs do not illuminate or the audible tone test is not heard during the automatic self-test, turn the unit off and then turn the unit back on to cycle it through the self-test. If this does not resolve the problem, do not attempt to use the Aquamantys Pump Generator and refer to the Aquamantys Service Manual.

   If you are unable to correct the malfunction, use a backup generator or traditional hemostatic techniques to complete the surgical procedure.

Section 8 - Error Codes and Error Handling

The Aquamantys Pump Generator self-test, which is executed immediately following power up, comprises several phases. The first phase covers the internal RAM and the MPU0 watchdog test. The second phase tests the major computer hardware components (microcontroller). The third phase tests the NV-RAM and the separate RFGEN modules for potential errors. Portions of this self-test are repeated in the background during normal use (see "Checked During Use?" column of Error Code Description Table).

If an error is detected, the respective test is repeated at least once in order to exclude sporadic deviations. If the deviation remains, the self-test aborts, an error message is generated, and the unit enters the safe state. The safe state disables all functions of the pump generator until the error condition is cleared.

Error display during the self-test

While in the safe state following the detection of a self-test error, the power setting display will repeatedly sequence through three displays. The first display is "Err", followed by the error number, followed by the measured value.

Table 8-1. Error Display

Display Description	Display format
Err	Err
Error Code Number	XXX
Measured value	XXX

Error handling

As a first response to an error indication, it is recommended to turn the power off to the unit, wait for approximately 15 secs, then turn it on again to repeat the self-test.

Table 8-2. Error Code Descriptions

Error No.	Brief description	Checked During Use?	Recommended Troubleshooting Sequence				Remarks
			RFGen Bd	Power Supply	Display Bd	Test Resistor	
001	CRC check error		1				
002	RAM test error		1				
003	CRC check error	YES	1				
004	Watchdog error		1				
005	Local I²C BUS errors (EEPROM)	YES	1				
006	Controller I²C BUS error	YES	1		2		
007	μController defective	YES	1				
008	Software inconsistency	YES	1				
009	Heat sink MP1	YES	1	2			**Note 1**
010	Heat sink MP2	YES	1	2			**Note 1**
011	Case temperature	YES	1	2			**Note 1**
013	int. A/D converter, reference voltage and analog multiplexer	YES	1	2			
014	Ground	YES	1	2			
015	High power supply 0 V test		1	2			
016	High power supply watchdog test/		1	2			
017	Power supply Enable test		1	2			
018	Power down test		1	2			
019	High power supply error U test		1	2			
020	High power supply error I test		1	2			
023	MPU1 self-test error	YES					**Note 2**
026	Power level 2 error		1	3		2	
027	Power level 3 error		1	3		2	
028	Power level 4 error		1	3		2	
029	Power level 5 error		1	3		2	
030	Power level 6 error		1	3		2	
032	RF enable error		1				
033	Current level 0 error		1	3		2	
034	Current level 1 error		1	3		2	
035	Watchdog reset	YES	1				
036	Excess output: power	YES	1	3		2	
037	Faulty variable contents	YES	1				
038	Mutual time monitoring of MPUs	YES	1				
039	Power supply voltage exceeds tolerances	YES	1	3		2	
040	Power supply current exceeds tolerances	YES	1	3		2	
041	Oscillator frequency exceeds tolerances	YES	1				
042	Pump voltage exceeds tolerances	YES	2	3			**Note 3**
043	Pump current exceeds tolerances	YES	2	3			**Note 3**
044	Power down capacitor test		1	2			
045	Power failure occurred	YES					
046	Command error	YES	1				

Error Code Notes:

1) Check (listen) for proper blower operation. Ensure that the recommended duty cycle (40 secs on/80 secs off) is observed.

2) Error code 023 (MPU1 error) has it's own subset of error conditions. See MPU1 Error section below.

3) Check proper functioning of pump motor.

MPU1 Error Codes:

When an error code 023 is encountered during the self-tests described in the table above, the display sequence is reallocated for a subset of error codes specific to MPU1 errors. The power setting display will still repeatedly sequence through three displays, but the first display is "Err", followed by 023 to indicate the primary error number, followed by the unique MPU1 error code.

Table 8-3. MPU1 Error Display

Display Description	Display format
Err	Err
Primary Error Code	023
MPU1 Error Code	XXX

Table 8-4. MPU1 Error Code Description

Error No.	Brief Description	Checked During Use?	Recommended Troubleshooting Sequence			
			RF Gen Bd	Power Supply	Display Bd	Test Resistor
023 / 001	CRC check error		1			
023 / 002	RAM test error		1			
023 / 003	CRC check error		1			
023 / 004	Watchdog error		1			
023 / 005	Local I²C BUS errors (EEPROM)		1			
023 /006	Controller I²C BUS error		1		2	
023 / 007	μController defective		1			
023 / 008	Software inconsistency		1			
023 / 009	+5 V AD converter or reference voltage error		1	2		
023 / 010	+15V error		1	2		
023 / 011	-15V error		1	2		
023 / 012	Ground, AD converter error		1	2		
023 / 013	Relay test		1	2		
023 / 014	Mutual time monitoring of MPUs		1			
023 / 043	Handpiece detection test, open test sense line, negative pulse		1			
023 / 044	Handpiece detection test, open test sense line, positive pulse		1			
023 / 045	Handpiece detection test, diode test sense line, negative pulse		1			
023 / 046	Handpiece detection test, open sense line, positive pulse		1			
023 / 050	Command error		1			

Section 9 - Service Access

The Aquamantys Pump Generator should only be serviced by a qualified technician. Removal of the bottom cover voids any warranty.

Opening the unit

To open, turn the unit upside down and remove the floor panel. To do so, remove the screws with a Philips screwdriver and take off the floor panel. If required, remove the locking nut that fastens the protective ground cable.

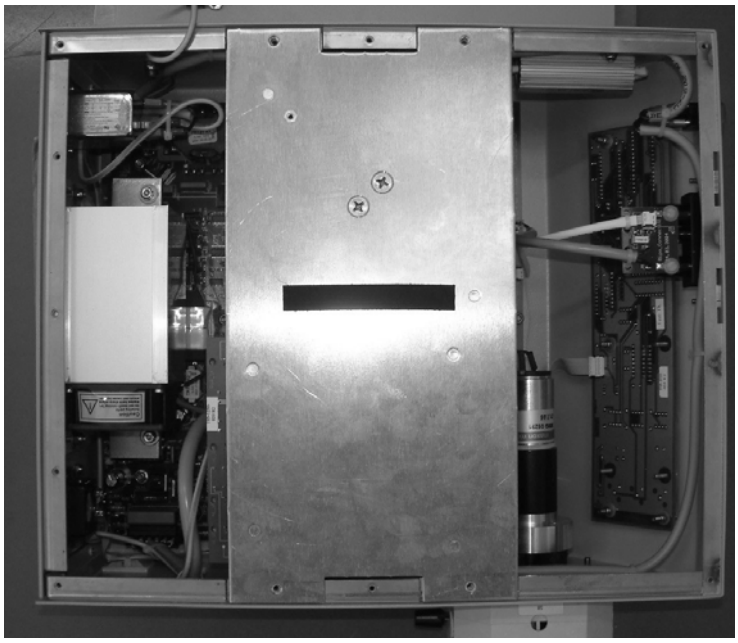


Figure 9-1. Floor panel removed

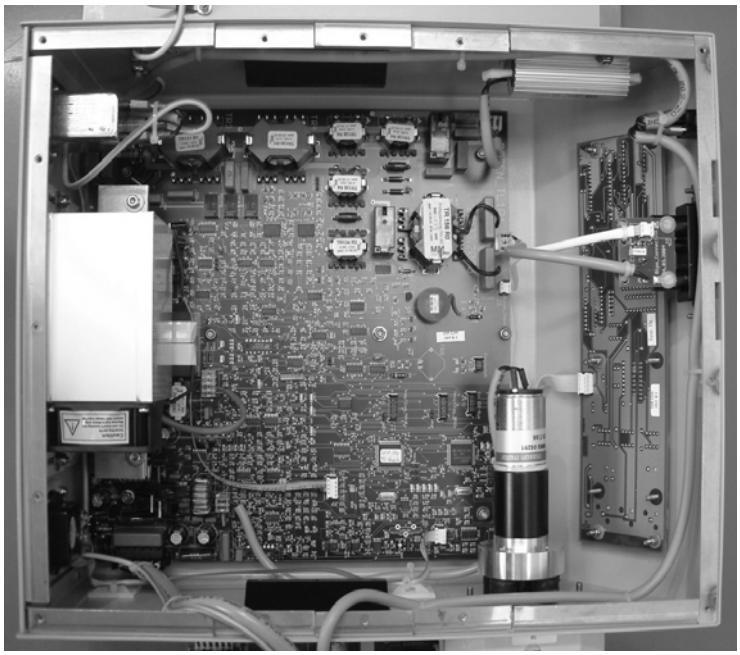


Figure 9-2. Power Supply removed

Removing the power supply unit

The power supply PCB and the mains transformer – the power supply unit – are mounted on an aluminum plate. After removal of 4 Philips screws the entire power supply unit can be lifted and deposited next to the unit.

Warnings: *Beware of energized components! Power supply removal and handling is permitted only if the unit is separated from mains. The power supply capacitors can hold a charge for several minutes after separation from mains. Reversing the connectors from power supply PCB to RF generator PCB can damage the latter even if the unit is separated from mains because the power supply capacitors can still hold a charge!*

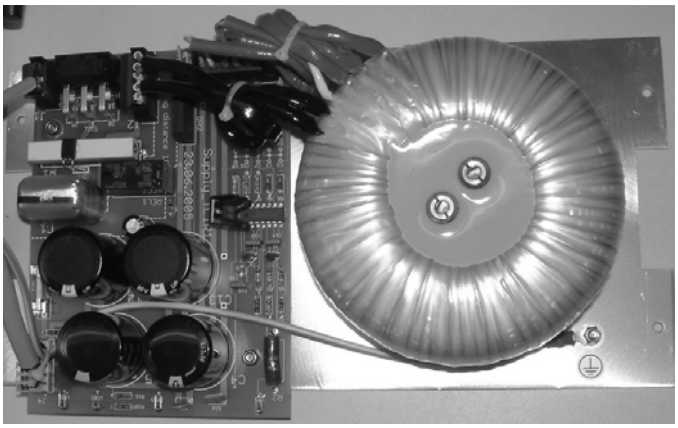


Figure 9-3. Power Supply

Removing the rear panel

The rear panel is fastened to the housing with 4 screws. The cooler fan unit is screwed to both the rear panel and the heat sink on the RF generator PCB (RFGEN_TL1). To remove the rear panel you must unscrew the screws that fasten the cooler fan unit to the heat sink. You can swing down the rear panel after having disconnected the fan and loudspeaker connectors. You can fully remove the rear panel after unplugging the connectors on the line filter.

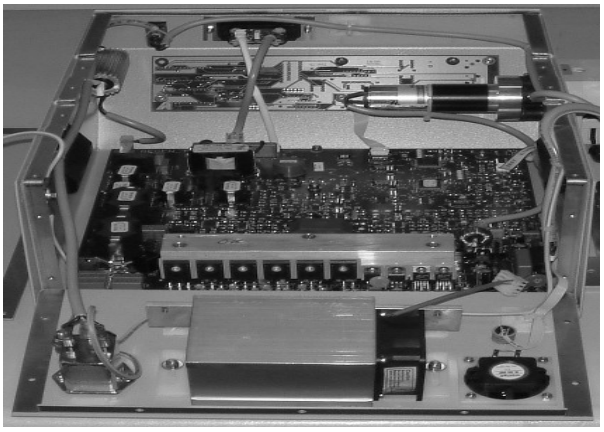


Figure 9-4. Rear Panel removed

Removing the RF generator PCB (RFGEN_TL1)
First remove the rear panel and unplug all connectors. 7 nuts hold the RF generator PCB in the housing. Unscrew them, remove the washers and the two serrated washers and carefully lift the PCB out. Make sure during installation (replacement) of the RF generator PCB that the serrated washers are installed in the same positions (bores with copper ring in the PCB) as these serve for equipotential bonding with the housing. When replacing the PCB apply a thin layer of thermal compound on the heat sink to improve heat transfer to the cooler fan unit. Caution: Make sure not to reverse the connector to the power supply PCB because residual charges in the power supply capacitors can damage the electronics. Therefore plug in on the power supply PCB first. Then fit the Riacon connector with its "large face" towards the big capacitor (C121).

Removing the power supply PCB (Supply_TL1)
The PCB is fastened to the power supply unit (aluminum plate) with 4 nuts. Make sure during installation (replacement) that the serrated washer is installed in the same position (bore with copper ring) as it serves for equipotential bonding with the housing. Do not reverse the connector to the RF generator PCB (residual charge in power supply capacitors) (See Section 3.4).

Removing the cooler fan unit

After swinging down the rear panel, disconnecting the fan cable and removing the two fastening screws you can take the cooler fan unit off the rear panel. Screw on but do not yet tighten the two nuts holding the cooler fan unit during installation. Tighten them only when the rear panel has been completely installed and the fan unit screwed to the heat sink; this will ensure the cooler fan unit is fastened without stress. Apply some thermal compound to enhance the heat transfer when replacing the cooler fan unit.

Removing the pump head and the drive unit

Unscrew the two fastening screws to remove the pump head.
To remove the drive unit, unscrew the 4 screws on the housing after having removed the pump head and the connector to the RF generator PCB.

Section 10 - Schematic Diagrams

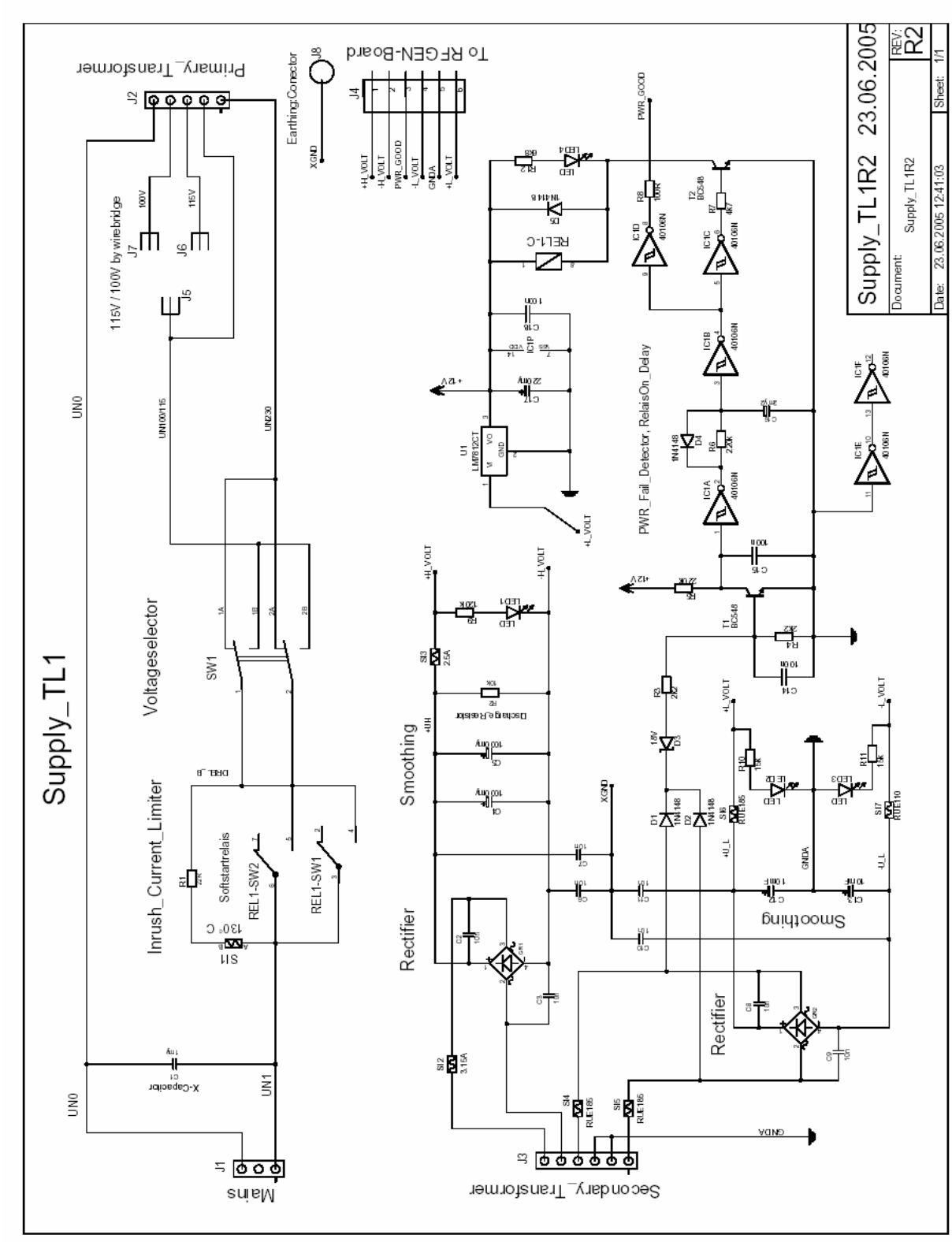


Figure 10-1. Supply_TL1

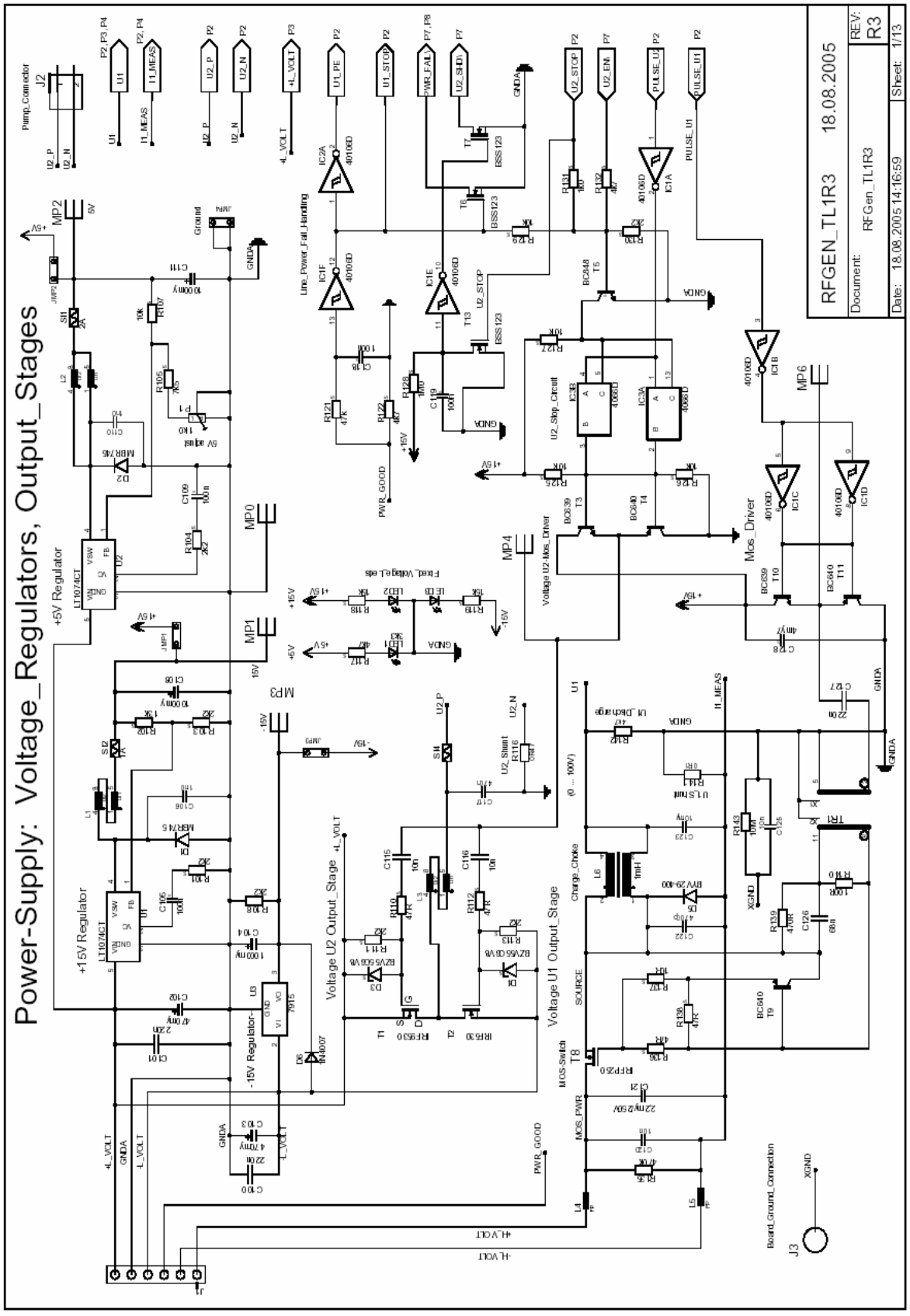


Figure 10-2. Power Supply: Voltage Regulators, Output Stages

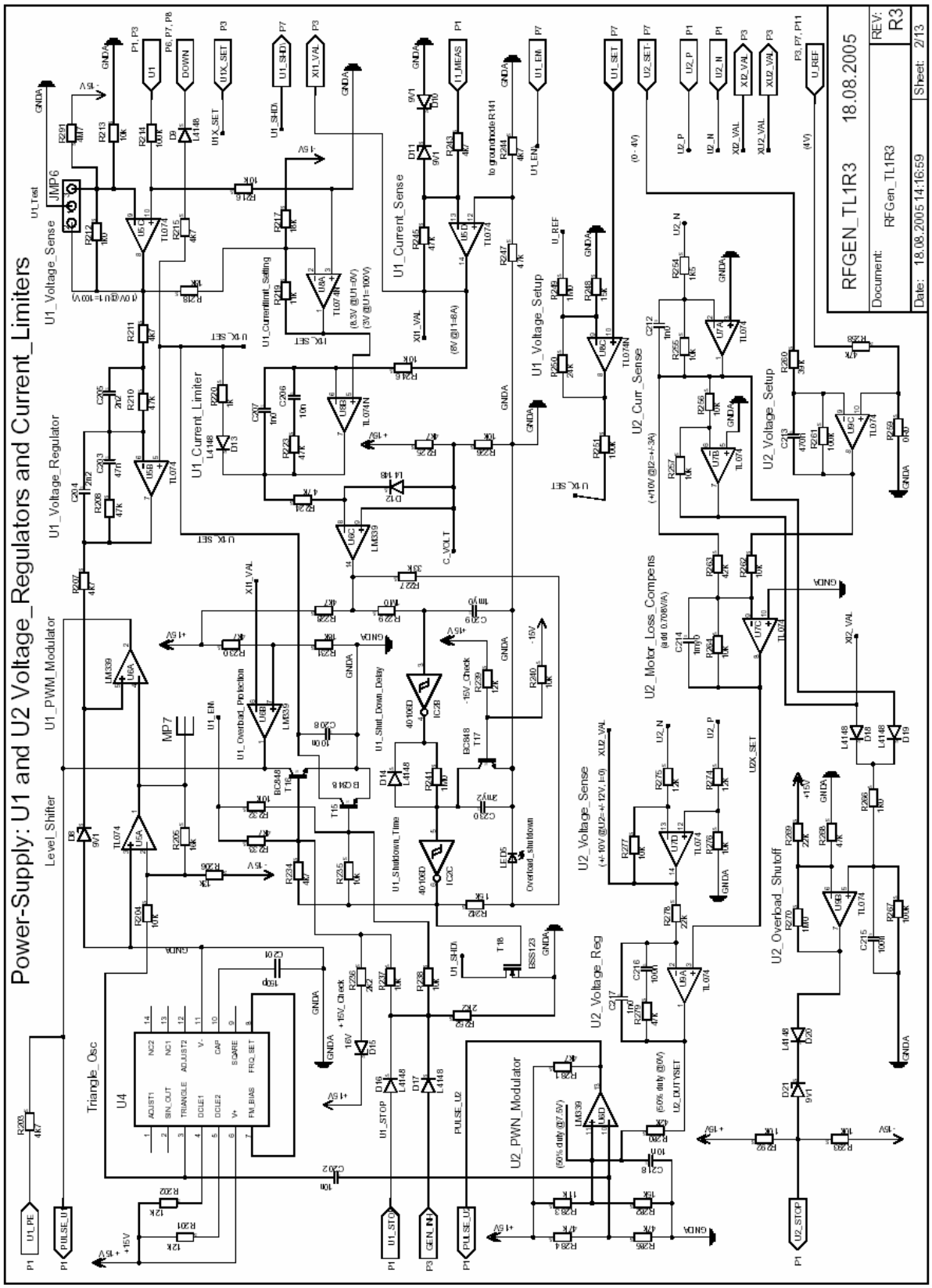


Figure 10-3. Power Supply: U1 and U2 Voltage Regulators and Current Limiters

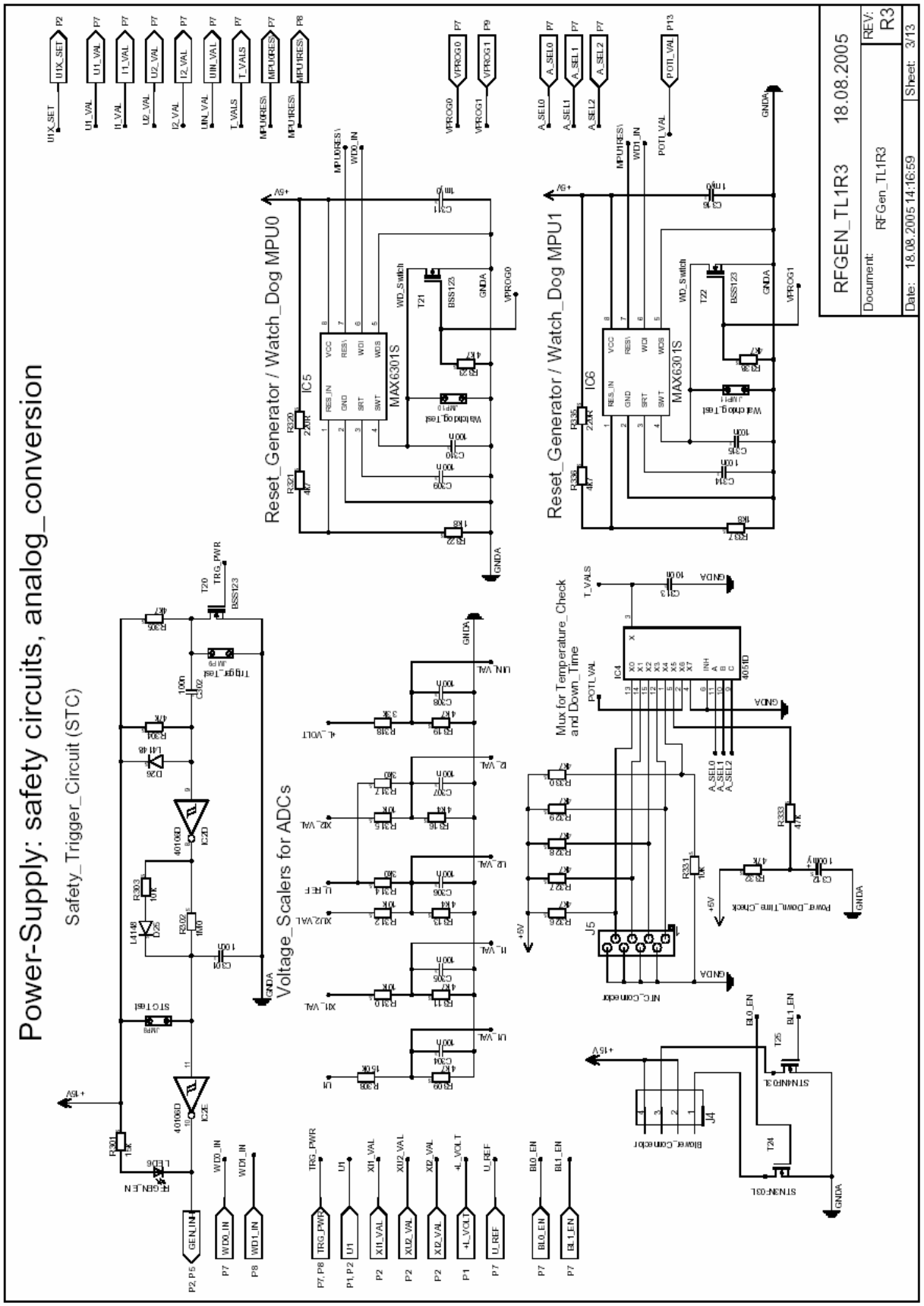


Figure 10-4. Power Supply: Safety Circuits and Analog Conversion

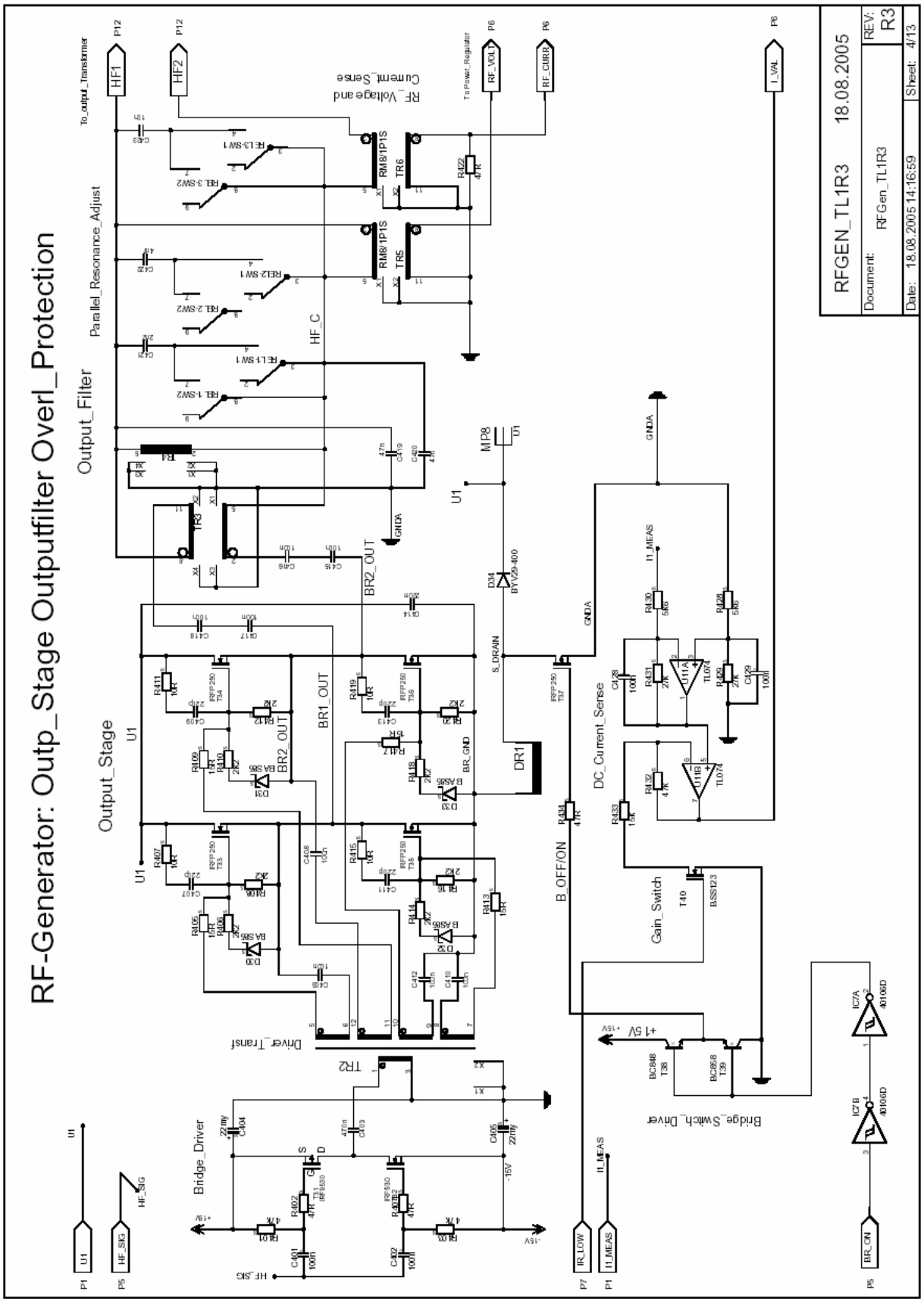


Figure 10-5. RF Generator: Output Stage, Output Filter Overload Protection

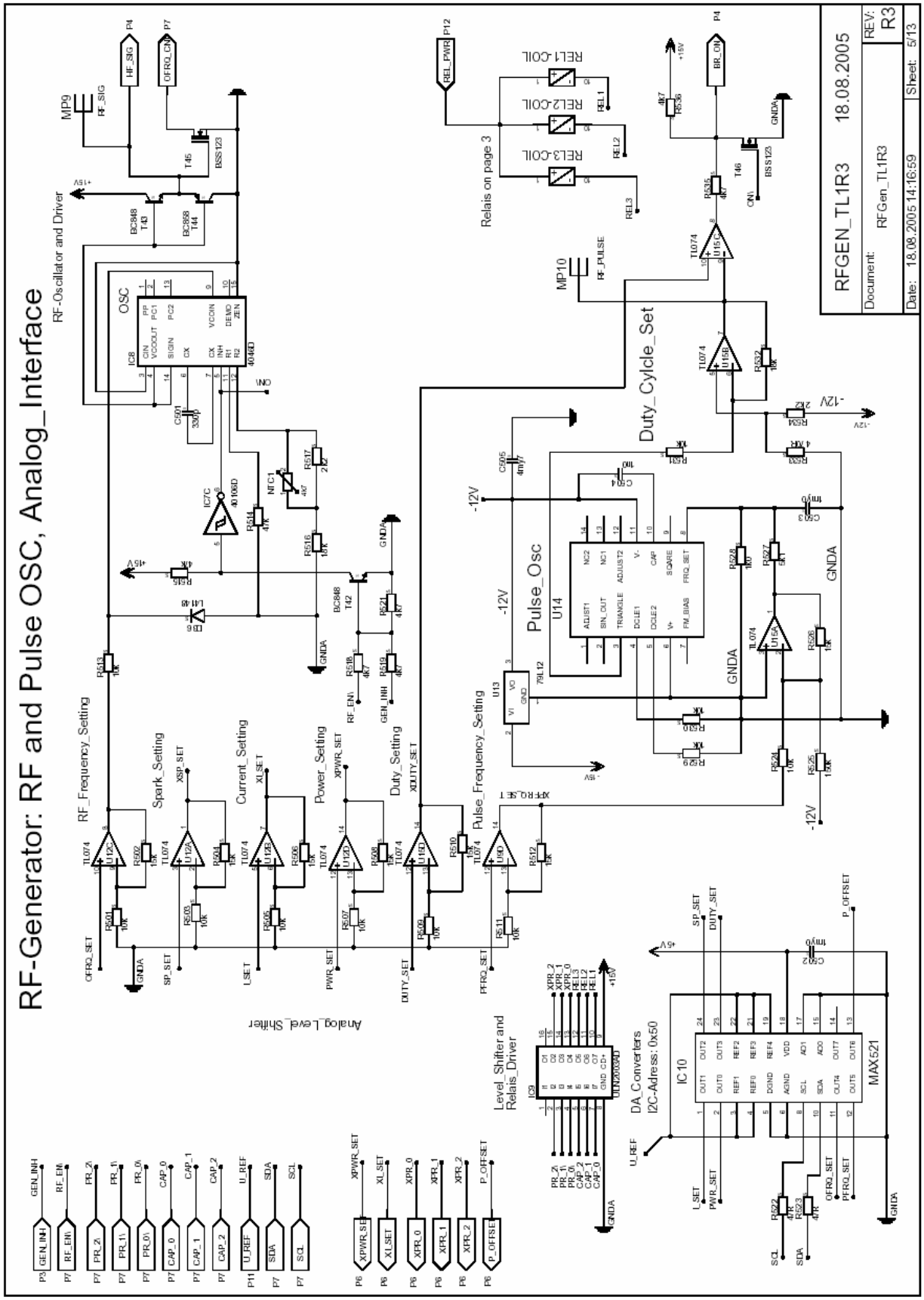


Figure 10-6. RF Generator: RF and Pulse Oscillator, Analog Interface

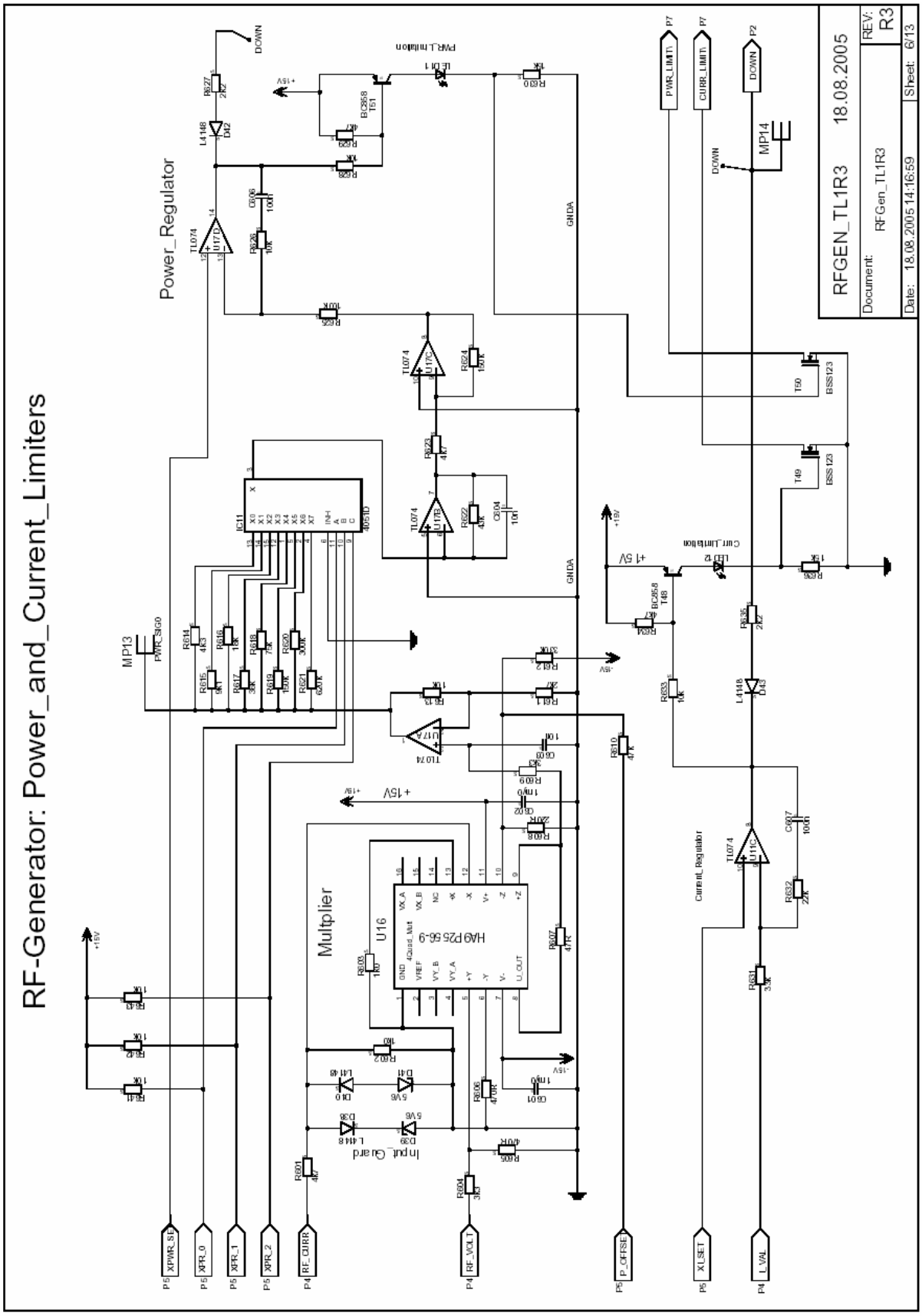


Figure 10-7. RF Generator: Power and Current Limiters

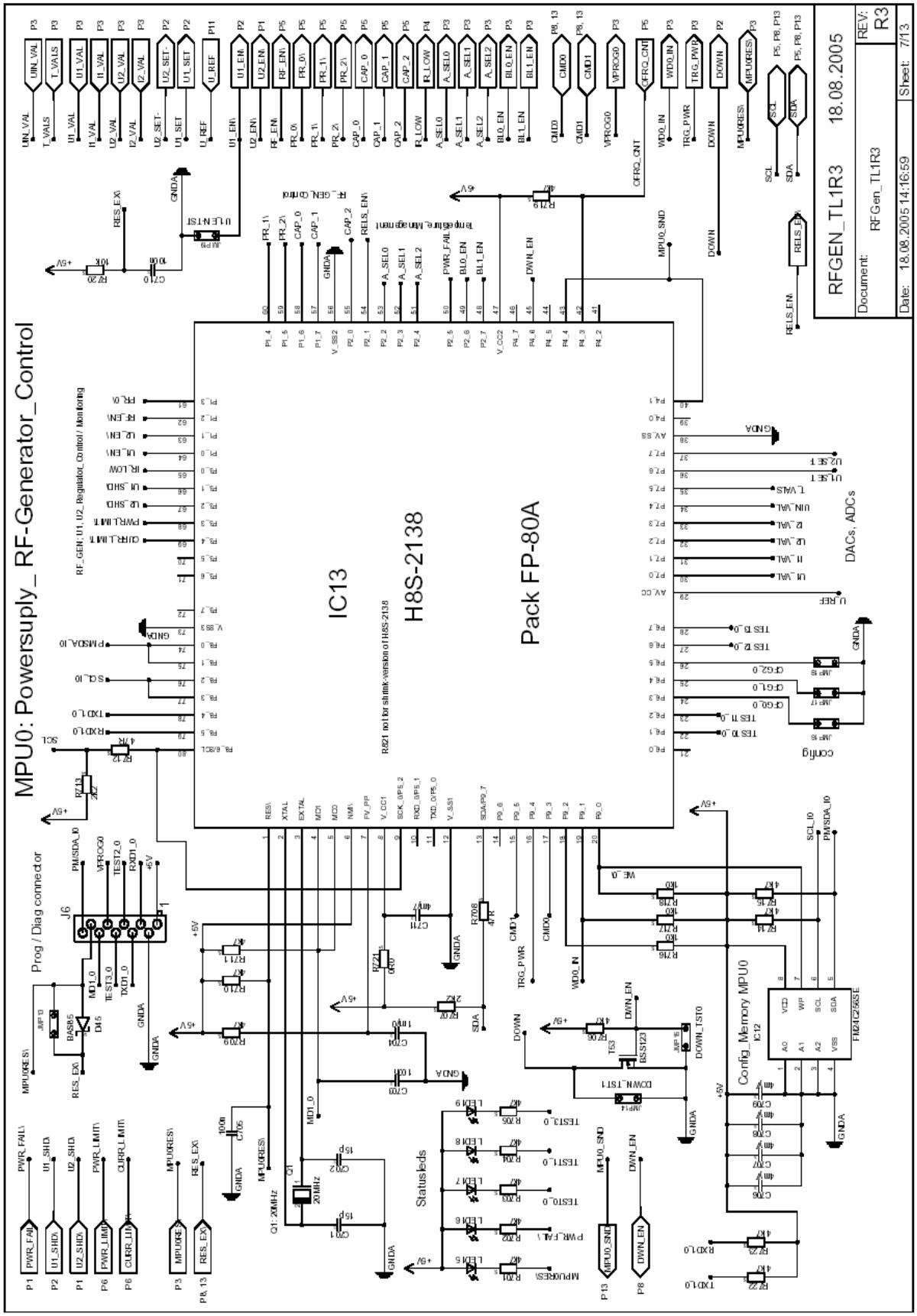


Figure 10-8. MPU0: Power Supply, RF Generator Control

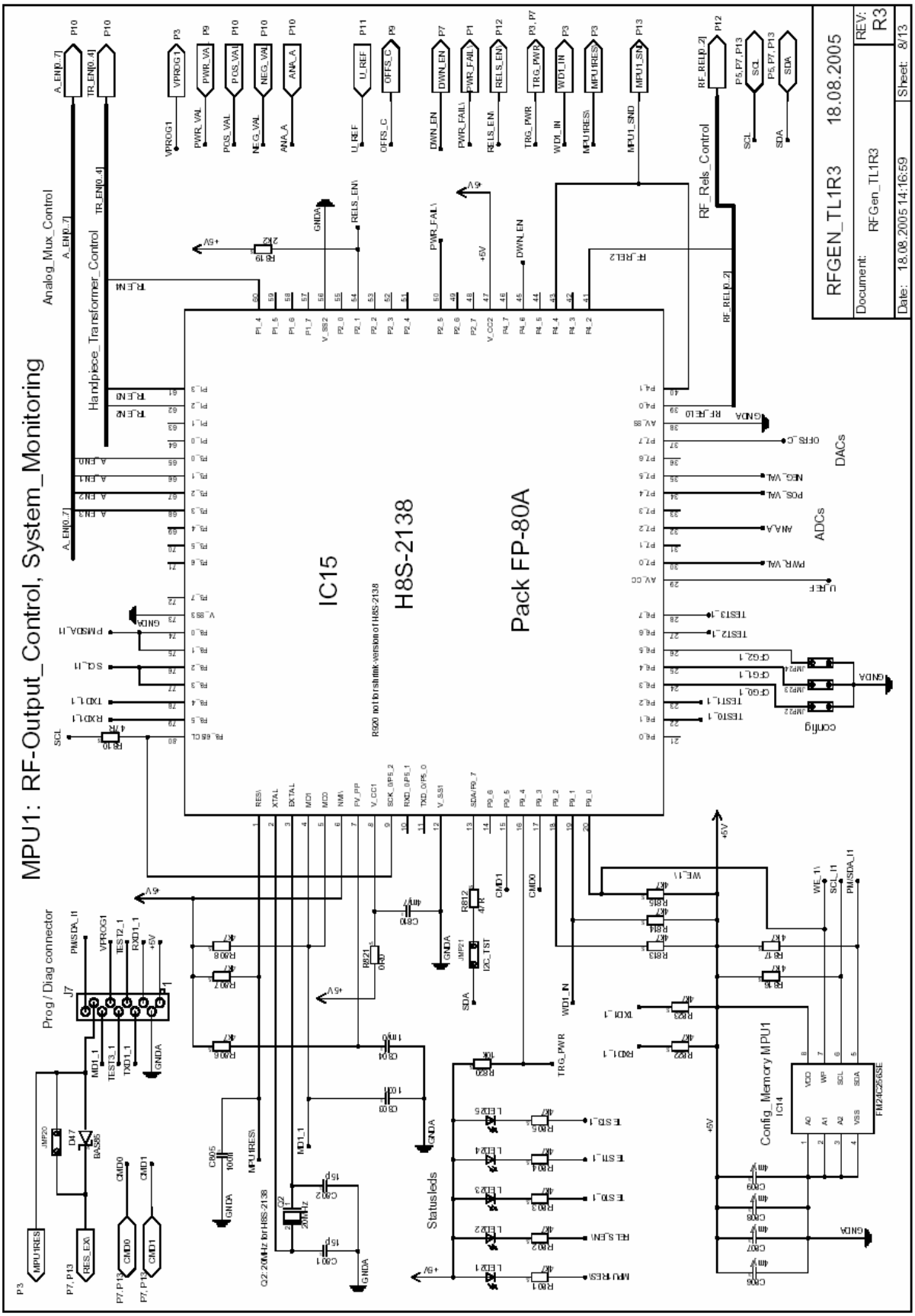


Figure 10-9. MPU1: RF Output Control, System Monitoring

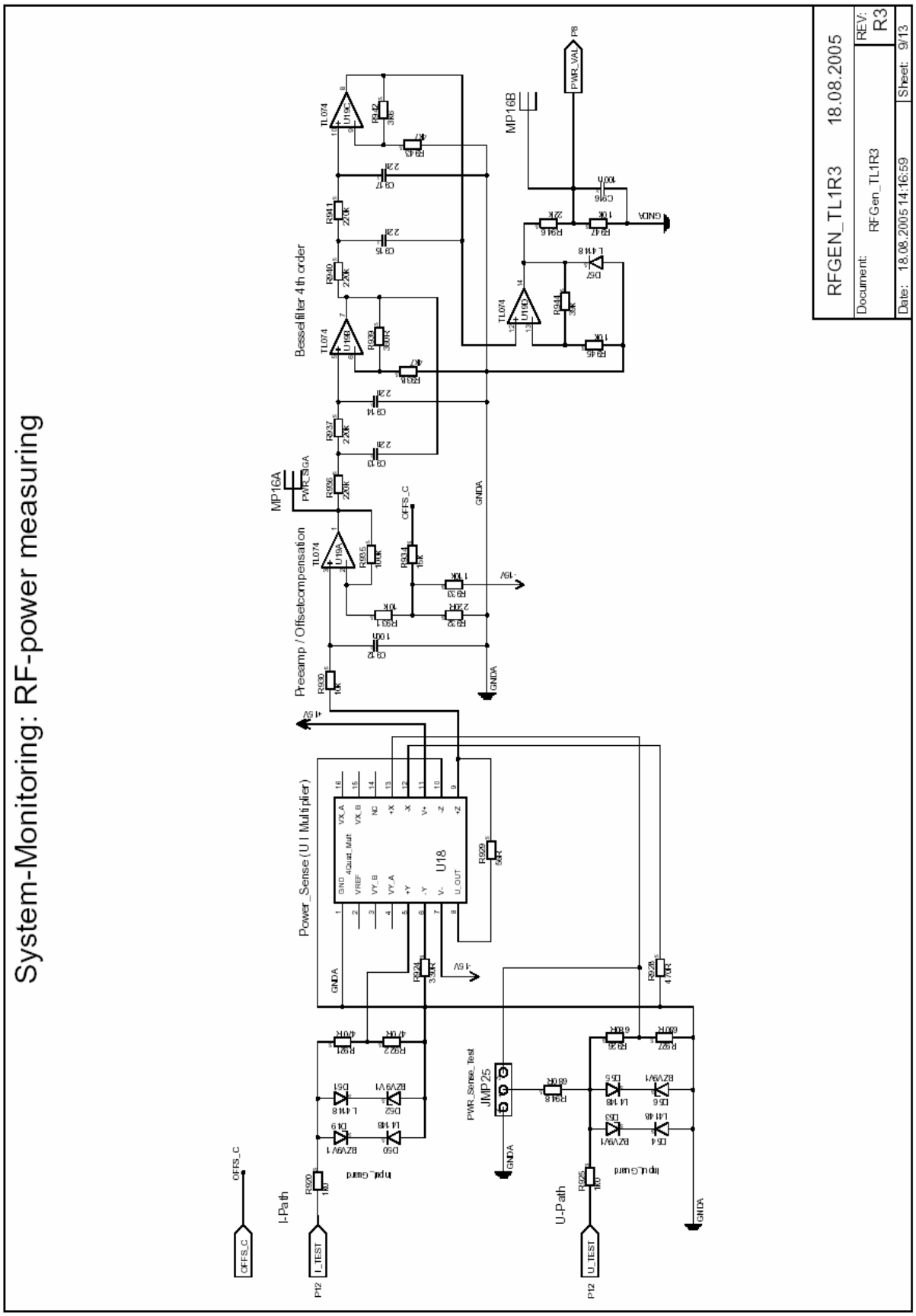


Figure 10-10. System Monitoring: RF Power Measuring

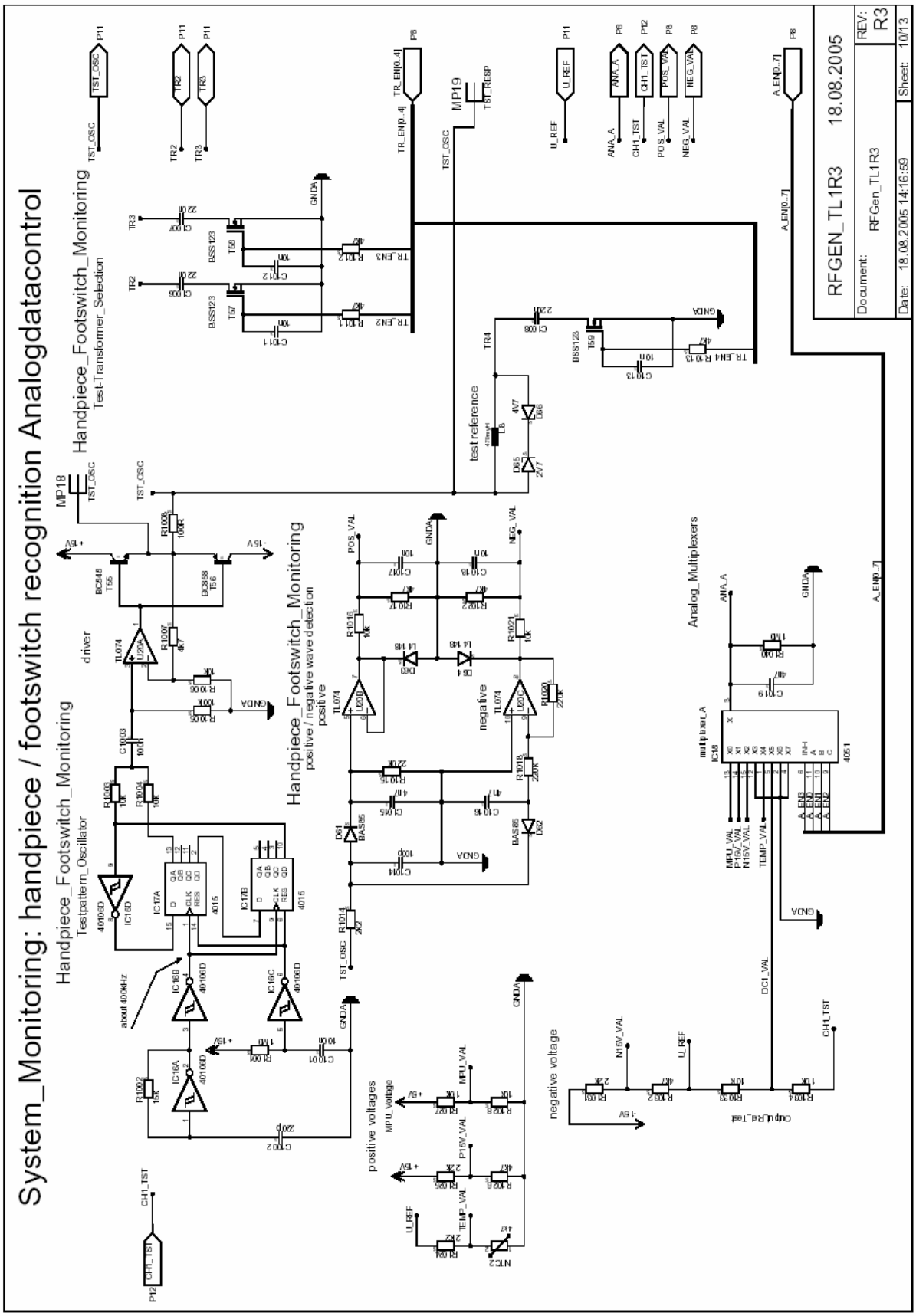


Figure 10-11. System Monitoring: Hand Switch Recog., Analog Control

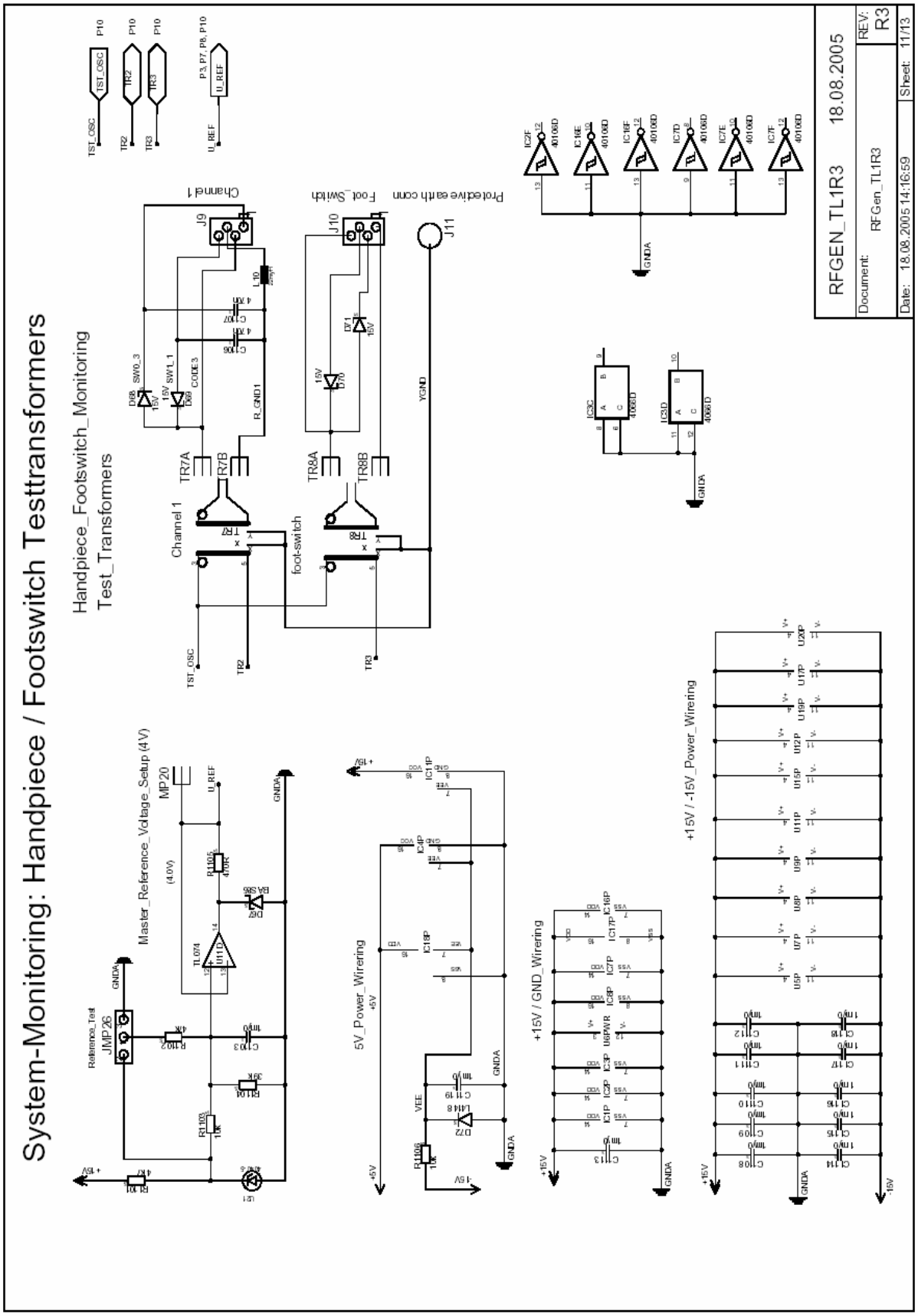


Figure 10-12. System Monitoring: Hand Switch Test Xfmr

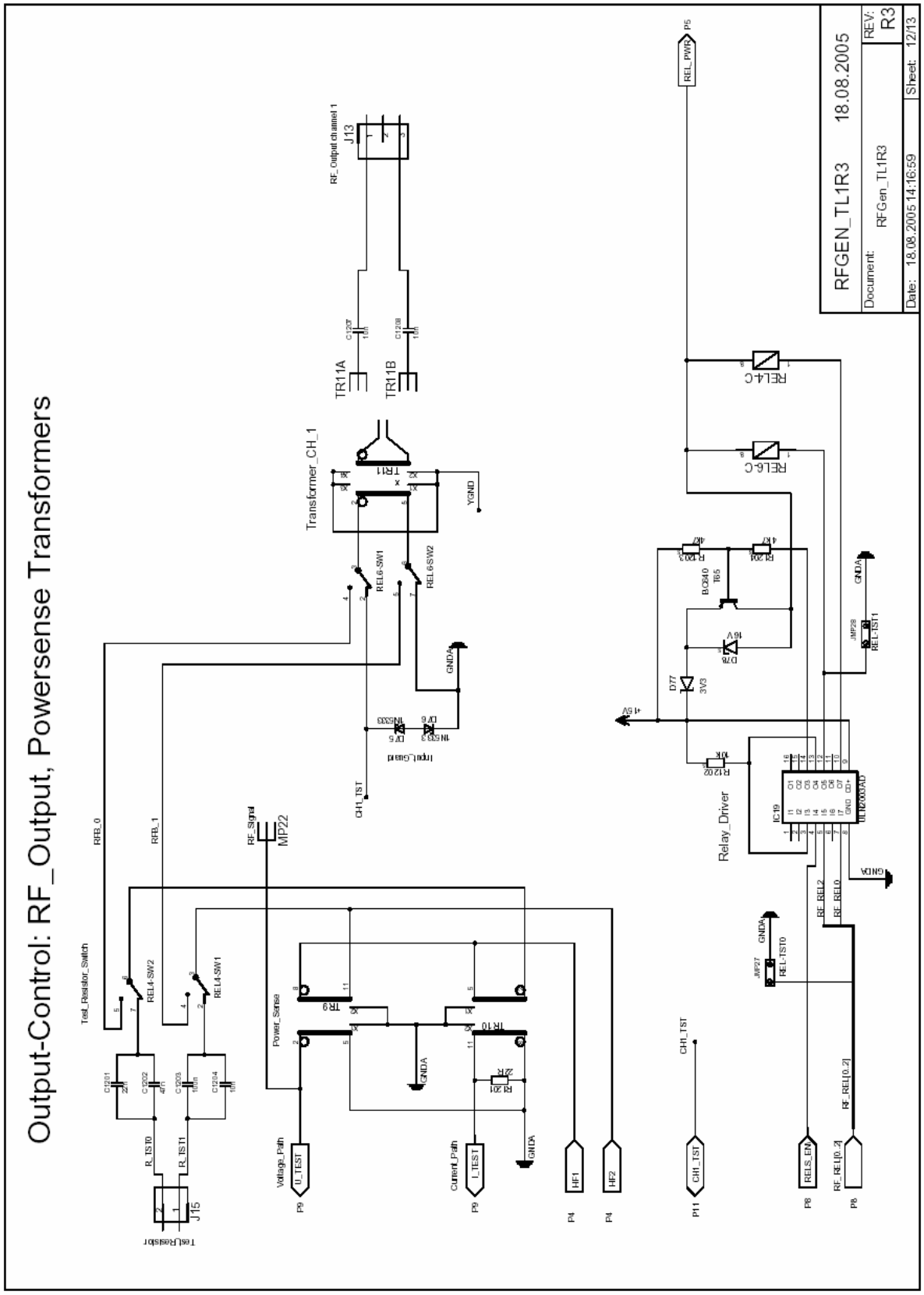


Figure 10-13. Output Control: RF Output, Power Sense Xfmrs

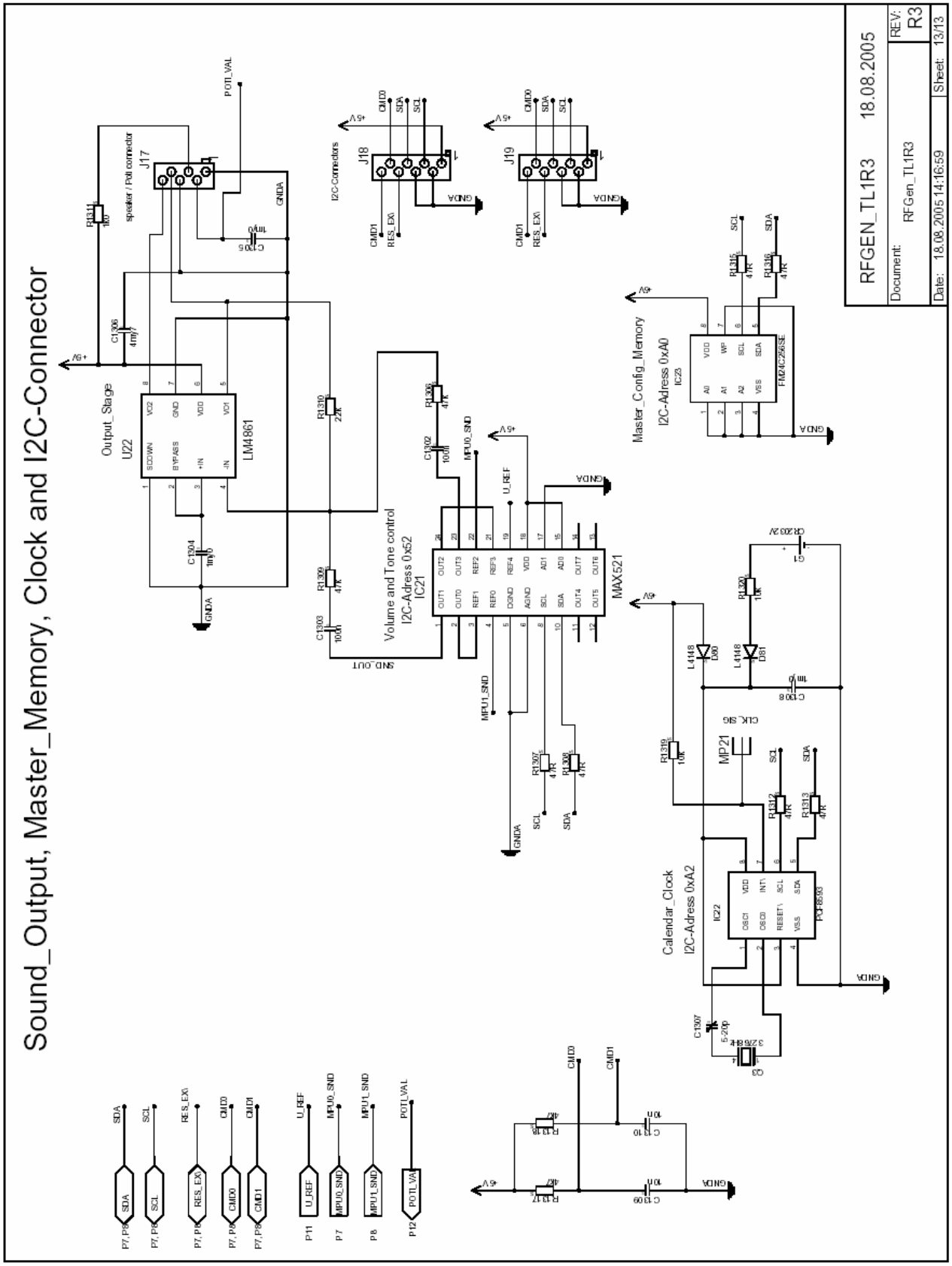


Figure 10-14. Sound Output, Master Memory, Clock, I²C

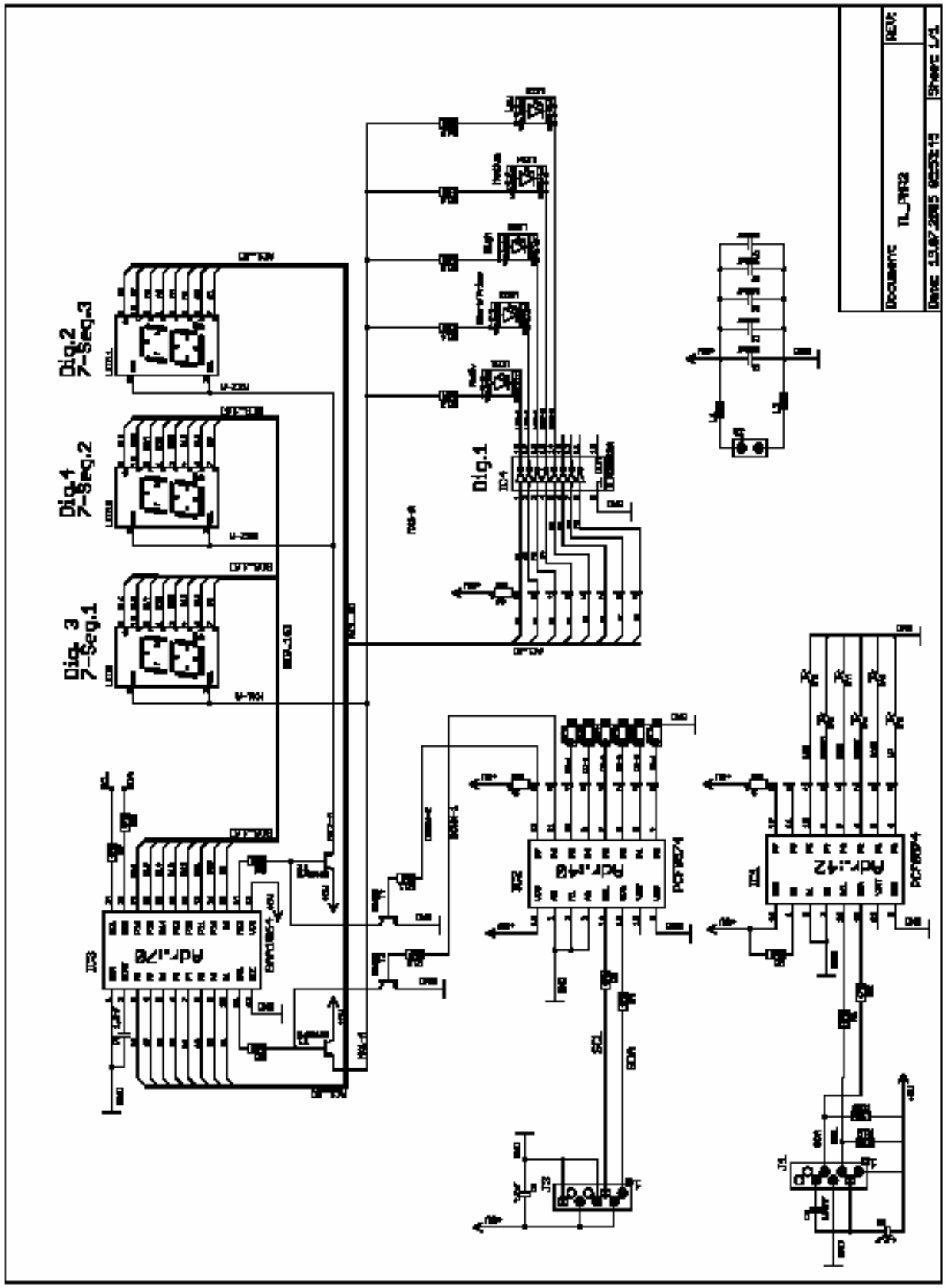


Figure 10-15. Display Board

Section 11 - Warranty

LIMITED EXPRESS WARRANTY

For one (1) year from the date of shipment from TissueLink, if an Aquamantys Pump Generator or Cart is found, to TissueLink's satisfaction, to be inoperable during normal and proper use in accordance with applicable instructions, TissueLink Medical, Inc. will repair or replace the product, at its sole option, provided the product is returned, freight prepaid, in accordance with all return packaging and shipping instructions. A product repaired or replaced under this warranty will be warranted for the remainder of the original warranty period.

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